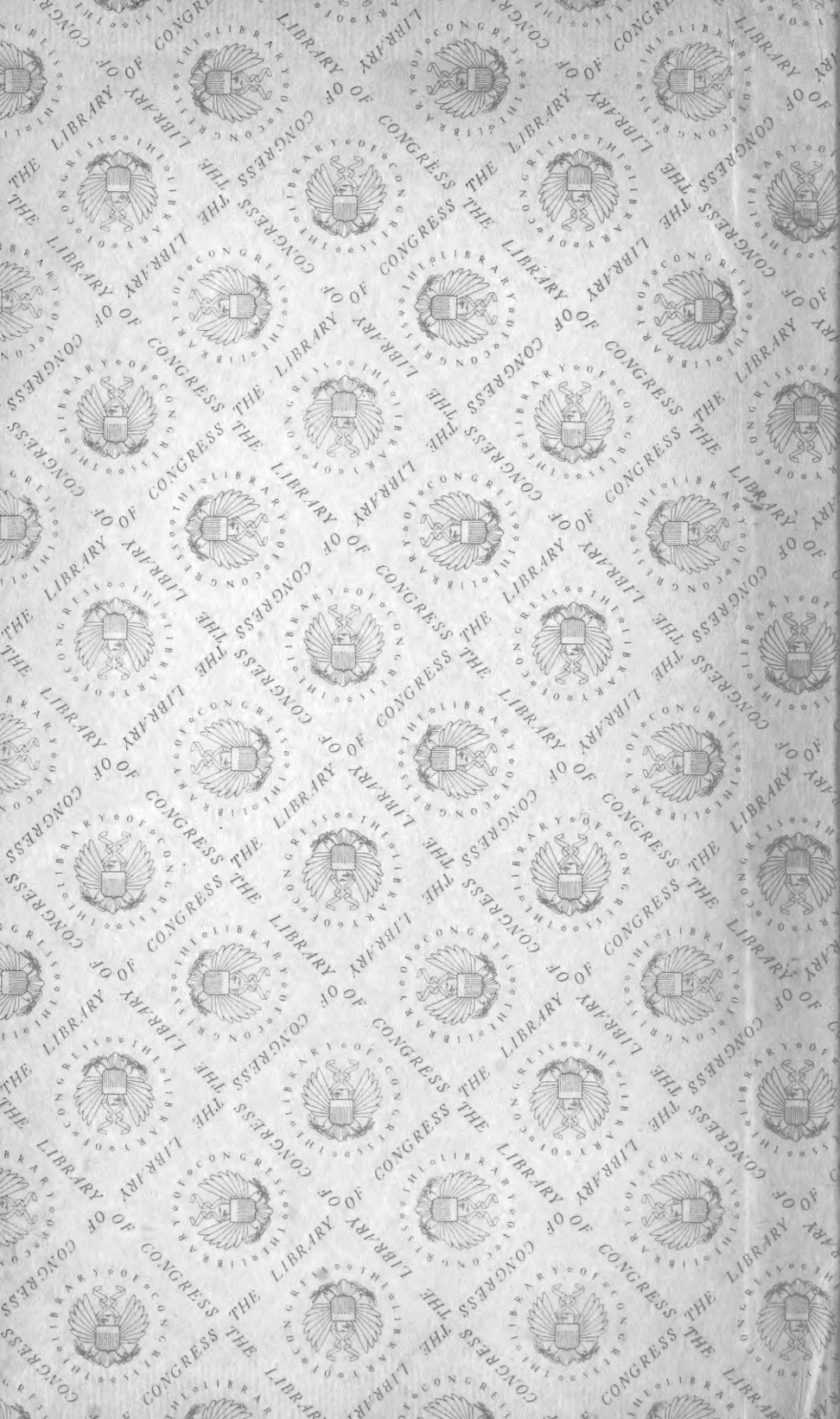


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AMERICAN FISHERIES

A HISTORY OF THE MENHADEN

BY
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G. BROWN GOODE

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WITH AN ACCOUNT OF THE
AGRICULTURAL USES OF FISH

BY
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PROFESSOR OF CHEMISTRY, WESLEYAN UNIVERSITY; SPECIAL CONTRIBUTOR TO AMERICAN AGRICULTURIST

AND AN INTRODUCTION, BRINGING THE SUBJECT DOWN TO DATE

THIRTY PLATES



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INTRODUCTION.

THE following HISTORY OF THE MENHADEN, having been prepared for the fifth annual report of the Commissioner of Fisheries for the year 1877, makes no claim to completeness for the subsequent years, though much of the history of the season of 1878 was added while the book was passing through the press. In this SPECIAL EDITION of the work it has been thought desirable to add, in the form of an Introduction, an account of several interesting observations recently made, and to include the reports of the Oil and Guano Associations down to the present time.

The most important phase of the subject is the complete absence of the menhaden, in 1879, from the waters of Cape Cod, resulting in a total failure of the very important fisheries on the coast of Maine. More than forty steamers went into the Gulf of Maine in July, to return in a few weeks without wetting their nets. The total catch for 1879 was one hundred barrels of fish, taken by one of the steamers in July, in Casco Bay. Mr. R. E. Earll, who visited the Booth Bay region in September, thus describes the general distress which is the result: "The total absence of porgies is causing no little loss to all interested. The shore fishermen have lost fully half of their time and over half of their usual catch from not being able to get any porgies to fish with, while the 'George'smen' from Cape Ann have been driven far out of their way, going even to Rhode Island and Connecticut to obtain their usual supply of porgy bait. Some have ventured to seek bait here, in the 'hedges' and traps of the river fishermen, and have frequently taken river-pilots and gone far up the Kennebec, often waiting fully a week before getting their supply. The oil and guano factories had gone to considerable expense in getting ready for the season's work, and their property is entirely idle. The factory hands and steamers' crews have been thrown entirely out of employment, and are perhaps less able than any of the other classes interested to bear such a loss. The general prosperity of the porgy fisheries, for some years past, has drawn to them a large class of workmen from other occupations. Some, in moving into this region, have built for themselves small houses, and have been depending on the summer's work for the means to pay for them or to complete them. Others have spent their entire means in getting their families located, and almost none have money laid up to carry them through the winter, and but little employment can be had from this time forward. They were all on hand to begin work the first of June, and kept waiting, in the hope that the fish would 'strike,' until late in August. When they at last gave up the idea, it was too late to engage in any other occupation. A few of them have gone out in small boats to 'hook' for

mackerel, but have met with indifferent success. After waiting for a long time for the fish to appear, the following firms allowed the crews to take their steamers south and sell the fish to factories there : Joseph Church & Co., 8 steamers ; Albert Grey & Co., 4 steamers ; Gallup & Holmes, 4 steamers ; Gallup, Morgan & Co., 3 steamers ; Fowler & Foote, 2 steamers ; George W. Miles & Co., 2 steamers ; Tuthill, French & Co., 3 steamers ; Maine Oil Co., 2 steamers. Three steamers spent a short time in seining mackerel, landing a total of about 550 barrels."

The absence of menhaden north of the Cape does not seem to have been compensated for by any remarkable abundance in southern New England, where most of the other factories were located. They are said to have been enormously plenty on the New Jersey coast, and here as well as in Long Island Sound and the Chesapeake, the unusual abundance of young and middle-sized fish has occasioned general remark. The total catch for 1879 will probably fall below that for 1878, although in southern New England it will exceed the average, owing to the unusually large number of steamers fishing in those waters throughout the summer.

Mr. N. B. Church, of Tiverton, R. I., communicates to Professor Baird his experience in 1878 and 1879 : "I find that I caught my first school of porgies in 1878, May 3d, between Montauk Point and Shinnecock Light. There had been some caught previous to that by the Long Island fishermen. The menhaden came in large bodies, and remained in this vicinity about four weeks. The average yield of oil was about four quarts to the barrel of fish. The Maine fishing commenced June 7th—a little earlier than in previous years—and the fish were a great deal plentier than they usually are when they make their first appearance. They were very plenty on the Maine coast during the season, but, contrary to custom, went further east, so that we were unable to catch as many as we would had they remained on their old ground. The body of porgies left the coast of Maine about the last of September, and on the 9th day of October Cape Cod Bay was alive with them ; more, I think, than I ever saw there before. Our fish, caught east, yielded, on an average for the season, nearly two and a half gallons of oil to the barrel of fish. I can't tell exactly, as I never figured it. We had no fishing on the Rhode Island coast, owing to 'blow'y' weather.

"In 1879, the first fish were caught May 6th, some ten miles southward of Montauk Point. They were very plenty for five weeks, and a large quantity was taken. There has been a very large body all the season between Fire Island and Point Judith. Sometimes they were at one place and again at another—were moving all the time. Long Island Sound has been well stocked with them all summer. The steamer 'G. W. Humphrey,' of which I was master, caught, in 1878, 43,000 barrels ; in 1879, 60,000 barrels. Our yield of oil has not been large this season—not averaging over four quarts to the barrel of fish."

Mr. D. T. Church also describes the season of 1879 in Narragansett Bay : "Menhaden were found about the first of May between Montauk

and Sandy Hook, and they have not been seen east of there for any length of time since about the first of June. There was a heavy body seen off Rhode Island for ten days; they then disappeared as suddenly as they appeared. They struck on again in July, and the waters in this vicinity swarmed with them for two days, and then they again disappeared, and have not been seen since. Off Cuttyhunk, I hear, they were seen in large quantities in July. On the same date they appeared here, and left on the same day. I don't think the catch has been much larger this year than last. Last season they were easy to catch; this season hard to catch. The result has been less catch to a steamer, but there have been more steamers, and the result has been about the same."

Mr. R. L. Fowler, of Guilford, Ct., writes as follows: "A very few menhaden were caught in this vicinity by the 28th of April. This was about as early as usual. They became abundant by the 10th of July, and have not yet disappeared (November 29th). They have been as plenty as usual in this vicinity, but on the New Jersey coast there has been an unusually large quantity of them. Our firm, Fowler & Colburn, have used 23,500,000 fish."

Mr. Louis C. d'Homergue, of Brooklyn, writes of the season off New York: "The first menhaden for the season of 1879 were observed in sufficient quantities to warrant the commencing of fishing in the vicinity of Barren and Fire Islands on or about the first week in April. They were very abundant in April and May, less so in June and to September, when they began to scatter and spread so that it made it difficult to catch them. The fishermen called them 'wild.' They began to grow scarce from September 1st, showing also less oil to the thousand, and continued so doing until September 23d, when, up to October 6th, there came a perfect rush of them, yielding more oil than they had previously: this run over, they again became scarcer and thinner until the fall fishing commenced. Another run began about the first week in November, and quite a large additional quantity of fish were taken. They seemed to 'bunch up' well, but were poorer in oil than any previously caught, so that the fall fishing, in point of oil, was a failure. These fish, up to this date (November 27th), are lingering in our waters, but the four factories on Barren Island and the two on Fire Island have been closed since November 24th. My vessels cruised all the season between Fire Island and Barnegat."

Mr. James E. Otis, of Tuckerton, N. J., writes: "Menhaden were first caught here about April 25th, or nearly two weeks earlier than usual, becoming abundant about the middle of May, and continued so until about the middle of September. They have been very plenty this season along the coast of New Jersey, more so than for four years past. My vessels have taken some 3,000,000 each, the largest single haul being 125,000."

Mr. W. D. Hall, of Millan Creek, Va., says that in the Chesapeake region menhaden appeared about April 1st, became abundant about May 1st, began to grow scarce about June 15th, and that on November 30th some were still in the bay.

Menhaden appeared in Washington (D. C.) markets February 25, 1879, nearly three weeks in advance of the "branch-herring," four in advance of the shad, and eight before the "glut-herring."

The cause of the unusual movements of the menhaden in 1879 is difficult to ascertain. The idea has been suggested that they were driven back by the schools of blue-fish, which, by this theory, are supposed to have approached the coast in advance of them. This explanation seems scarcely satisfactory, for there is no evidence that the blue-fish were earlier than usual. On the other hand, there is reason to doubt whether blue-fish ever come near the coast until they are lured in by the presence of their favorite food. See the table, on page 46, which shows that for thirteen years the menhaden always entered Waquoit Bay from five to twenty days in advance of the blue-fish. In fact blue-fish, as well as menhaden, have been unusually scarce north of Cape Cod in 1879.

A more satisfactory explanation is to be found in the unusual coldness of the water in the Gulf of Maine. The following preliminary conclusions have been reached, but I hope in future to be able to discuss the subject more at length :

The season of 1878, in Maine, was fairly successful, the three summer months being warmer than in 1877, but cooler than in 1876. The absence of the menhaden schools, north of Cape Cod, in 1879, may be explained by the study of the temperatures of the water of the Gulf of Maine, as indicated by the observations made in Portland harbor. The averages for the three summer months are as follows, the numerator of the fraction being the average surface temperature, the denominator that of the bottom :

1876, $\frac{62.5}{57.9}$	1877, $\frac{58.5}{56.7}$	1878, $\frac{61.5}{58.1}$	1879, $\frac{56.1}{54.6}$
---------------------------	---------------------------	---------------------------	---------------------------

The average for the three summer months of 1879 is less than that of June, 1876. In August, 1878, there was a very rapid fall in the temperatures of the surface in the Gulf of Maine, so that the average of that month was less than that of July, instead of being higher, as is usual. This, perhaps, had the effect of driving the fish into the warmer water of the bays and estuaries. The monthly averages for 1876, 1877, 1878, and 1879, are as follows :

1876, June, $\frac{56.9}{54.0}$	July, $\frac{66.7}{59.4}$	August, $\frac{63.9}{60.4}$
1877, June, $\frac{54.9}{53.3}$	July, $\frac{58.1}{56.3}$	August, $\frac{62.4}{60.6}$
1878, June, $\frac{56.8}{55.2}$	July, $\frac{66.9}{59.3}$	August, $\frac{60.7}{59.9}$
1879, June, $\frac{52.9}{51.7}$	July, $\frac{55.9}{54.1}$	August, $\frac{59.6}{58.0}$

While it is impossible to predict what may be the temperature of these waters in the future, there is little reason to fear that the absence of the menhaden will be permanent. Several of the leading firms have agreed to have water temperatures taken from their steamers in the coming season ; this cannot fail to throw much light on these puzzling subjects.

The sixth annual meeting of the U. S. Menhaden Oil and Guano Association was held in the United States Hotel, New York, Wednesday, January 8, 1879. The meeting was called to order by the President, Mr. R. L. Fowler, fourteen members being present. The minutes of the last meeting and the Treasurer's report having been approved, the following officers were elected : Mr. R. L. Fowler, President ; Mr. D. T. Church, First Vice-President ; Mr. B. F. Gallup, Second Vice-President ; Mr. H. L. Dudley, Secretary and Treasurer, and Captain John Luce, Messrs. T. F. Price, and R. L. Fowler, Executive Committee.

The meeting adjourned subject to the call of the chairman.

The following is the report of the Committee on Statistics for the year :

Number of factories in operation.....	56
Number of sail vessels employed.....	279
Increase over 1877.....	9
Number of steamers employed.....	64
Increase over 1877.....	1
Number of men employed.....	3,337
Increase over 1877.....	650
Amount of capital invested.....	\$2,350,000
Increase over 1877.....	302,388
Number of fish caught.....	776,779,250
Increase over 1877.....	189,155,125
Number of gallons oil manufactured.....	3,809,233
Increase over 1877.....	1,392,644
Number of tons guano made.....	55,164
Less than 1877.....	280
Number of tons guano dried.....	19,377
Increase over 1877.....	13,367
Number of gallons oil held by manufacturers January 15, 1878.	742,600
Increase in 1878, gallons.....	478,600
Number tons guano held by manufacturers, January 15, 1878.	885
Less than in 1877.....	6,390
Yield of oil per thousand, 1878, gallons.....	$4\frac{8}{10}$

THE FOLLOWING IS THE SIXTH ANNUAL REPORT OF THE SECRETARY OF THE ASSOCIATION OF THE
MENHADEN OIL AND GUANO MANUFACTURERS OF MAINE, FOR 1878.

NAMES AND POST-OFFICE ADDRESS.

	Amount Capital Invested.		Number Fishermen employed.	Number of Vessels.	Number of Steamers.	Average Number of Men at Works.	Number Barrels Fish taken at Works.	Number Barrels Fish sold for Bait.	Number Gallons Oil made.	Tons Crude Guano made.
	Factory.	Fish Gear.								
Joseph Church & Co., Round Pond, Me.....	\$95,000	\$120,000	142	....	8	75	190,837	4,250	524,000	5,500
Albert Gray & Co., Round Pond, Me.....	15,500	42,000	58	....	4	27	46,200	300	139,478	1,550
Gallup & Homes, East Boothbay, Me.....	23,000	50,000	60	....	3	22	46,847	175	153,000	1,400
Gallup, Morgan & Co., East Boothbay, Me.....	18,812	39,800	36	....	4	15	20,726	200	80,000	891
Bristol Oil Works, Round Pond, Me.....	15,500	22,500	30	....	2	18	23,440	890	69,150	700
Round Pond Oil Works, Round Pond, Me.....	15,000	6,000	....	....	....	Not operated this season.	....	....	....	....
Tutthill, French & Co., South Bristol, Me.....	10,000	22,000	40	....	3	12	24,093	700	74,200	722
Thoulin's Island Oil Works, Round Pond, Me.....	12,600	15,200	30	....	2	15	21,374	300	50,400	600
Maddocks Oil Works, Boothbay, Me.....	60,000	73,000	81	....	6	18	53,485	5,040	152,432	1,605
Pemaquid Oil Works, Bristol, Me.....	50,000	50,000	70	....	5	50	77,000	1,500	200,000	2,300
Fowler, Foote & Co., South Bristol, Me.....	18,000	24,000	26	....	2	11	16,109	....	42,985	446
L. Brightman & Son, Bristol, Me.....	30,000	....	....	....	Not operated.	....	Changed to Drying Factory	....	....	....
Suffolk Oil Co., East Boothbay, Me.....	30,500	16,000	30	....	2	15	17,554	125	47,512	586
George W. Miles & Co., East Boothbay, Me.....	25,000	28,000	24	....	2	16	17,116	100	42,300	466
Brown's Cove Oil Works, Round Pond, Me.....	15,000	8,000	....	....	3	Not operated this season.	....	....	76,097	770
Wells & Co., South Bristol, Me.....	15,000	45,000	34	....	....	17	24,886	....	....	....
Kenniston, Cobb & Co., Boothbay, Me.....	15,000	....	20	....	2	10	21,859	50	48,300	592
South St. George Oil Works, South St. George, Me.....	26,400	11,000	11	....	....	3	6,325	500	14,500	300
Coombs & Co. Factory, Harpswell, Me.....	2,500	1,500	....	1	....	....	....	....	....	....
Total.....	\$467,812	\$584,000	682	1	48	324	616,851	14,100	1,714,384	15,328
Gain over 1877.....	8,000	....	45	....	....	24	59,706	3,305	548,191	1,662
Loss from 1877.....	....	39,800	....	12	....	....	....	....	....	....

The following firms caught fish outside of Maine, but landed them at the factories, as follows:

JOSEPH CHURCH & Co.:		GEO. W. MILES & Co.:		PEMAQUID OIL WORKS:		FOWLER, FOOTE & Co.:	
Maine.....	195,254	Maine.....	195,254	Maine.....	54,000	Maine.....	14,889
Provincetown.....	19,335	Provincetown.....	19,335	Provincetown.....	7,000	Provincetown.....	1,220
West.....	45,628	West.....	1,351	West.....	16,000	Total.....	16,109
Total.....	190,837	Total.....	17,116	Total.....	77,000	Total.....	16,109

LUTHER MADDOCKS, Secretary.

In 1877 I was able to learn of but four oil and guano factories in operation on the Chesapeake Bay, and it was not thought necessary to make a special survey of that region, but in that and the following season the industry seems to have assumed considerable dimensions. I am indebted to Col. Marshall McDonald, Commissioner of Fisheries for Virginia, for the following memorandum, which, although not prepared by him, he considers to be in the main correct. It is an extract from a circular, without authentication, dated "Northumberland Co., Va., December, 1878." I have not been able to learn that the Chesapeake manufacturers are identified with the U. S. Oil and Guano Association. The proceeds of their industry, if added to those of the northern manufacturers, will considerably swell the statistical aggregates, increasing the total catch for 1878 to nearly 900,000,000 of fish, the total yield of oil to over 4,000,000 barrels, and of guano to over 30,000 tons.

LIST OF FIRMS ENGAGED IN THE MANUFACTURE OF OIL AND GUANO
FOR THE SEASON OF 1878, IN VIRGINIA.

1. Little Bay Oil and Guano Co., Little Bay, Lancaster Co., Va.
2. Whaley & Burgess, Mill Creek, Northumberland Co., Va.
3. N. H. Timbs, Fairport, " " "
4. E. W. Reed, " " "
5. Reed & Woodhull, Little Bay, Lancaster Co., Va.
6. Lampson & Grinell, Pecanatauck River, Middlesex Co., Va.
7. Taylor & Jackson, " " " "
8. G. T. Owens & Co., Fairport, Northumberland Co., Va.
9. W. D. Hall & Co., Point Pleasant, Northumberland Co., Va.
10. L. Cockerell & Co., Wicomico River, Northumberland Co., Va.
11. O. E. Maltby, New Point Comfort, Va.
12. Darling & Smithers, Hampton, Va.
13. Stearns & Co., Black River, Va.
14. Lewis Crockett, Tangier Island, Va.
15. Henry Crockett, " " "

"Being desirous to know the extent of the fishing interests of the Chesapeake Bay and its tributaries, we have looked up what information could be found, and herewith submit it to the careful inspection of those who take an interest in that direction. We find that in the year 1869 more than usual attention was turned to this matter, and we are able to gather the following details of its results from a party engaged in the business that season, viz. :

1869.

Men employed on vessels fishing.....	12
Vessels employed.....	4
Men employed making guano.....	9
Fish taken.....	3,000,000
Oil made.....	200 bbls.
Guano made.....	300 tons.

“The returns from those engaged in the business for 1878 is also appended, showing an increase of products encouraging to a vigorous prosecution of the enterprise, viz. :

1878.

Men employed on vessels fishing.....	286
Vessels employed fishing.....	78
Men employed on shore.....	201
Fish taken.....	118,309,200
Gallons of oil made.....	234,168
Tons of guano.....	10,832

“This industry is yet in its infancy, and the best means of handling the product of the fisheries of the rivers and bays of the State may not yet be fully understood, but with the ingenuity and energy of the fishermen and patronage of the farmers in the liberal use of the fertilizers made, and the protection of the Legislature we have no doubt that ultimately the enterprise and capital employed in this business will realize satisfactory results.”

The much-vexed problem of the spawning habits of the menhaden has been advanced a step nearer to solution by Mr. D. T. Church, who sends to the Smithsonian Institution, November 6th, a number of specimens of large menhaden, taken from a large school which appeared at the mouth of Narragansett Bay, November 1st. These fish had the ovaries nearly ripe, and probably would have spawned within a month. This is a very satisfactory corroboration of the views supported on pages 95-100.

Col. M. McDonald sends me four menhaden caught by him in gill-nets in Hampton Creek, Va., November 27th, one of which was full of nearly ripe eggs. Mr. d'Homergue states that the November fish at Barren Island are full of spawn.

Another very important result obtained by the study of these fish, is the first accurate approximation to an idea of the fecundity of this species. I wish to cancel the estimate of the number of eggs in the ovary of a menhaden on page 90. The particles counted at that time must have been agglomerations of eggs, so closely united in the immature ovary as to be incapable of proper separation. The eggs in the fish sent by Mr. Church are very much more minute than the first, and there cannot be less than 150,000, a number far exceeding the highest estimates for shad and herring, and indicating that the menhaden must be ranked among the most prolific of fishes.

The attempt of the Maine Legislature to regulate the fishery in that State has been of little moment, owing to the unexpected absence of the menhaden from that region. This movement has met with much opposition on the part of the oil and guano manufacturers. It is to be hoped that the constitutionality of the law will be tested in the courts.

G. BROWN GOODE.

ERRATA.

THE typographical blunders enumerated below are in large part due to the absence of the author from town when the proofs were being read.

Page 9, line 13, insert Eastern Maryland—Pilcher or Pilchard.

Page 44, line 39, for *Daniel Y. Church* read *David T. Church*.

Page 66, line 9, for *diagram sections* read *a diagram section*.

Page 68, line 24, for *paragraph* read *paragraphs*.

Page 77, insert heading to paragraph 102, *Recent changes in the northern limits of distribution*.

Page 89, line 7, for *fat-fish* read *fat fish*.

Page 93, line 17, for *ostracoda* and *copeopoda* read *Ostracoda* and *Copeopoda*.

Page 99, line 30, for *Boardman and Atkins* read *Goodale and Atkins*.

Page 115, line 1, for *F. T. Babson* read *F. J. Babson*.

Page 118, line 24, for *has already been described* read *is described below*.

Page 120, line 28, for *William T. Fithian* read *William Y. Fithian*.

Page 132, insert heading to paragraph 182, *The menhaden fishery and land industries*.

Page 161, insert heading to paragraph 224, *Comments*.

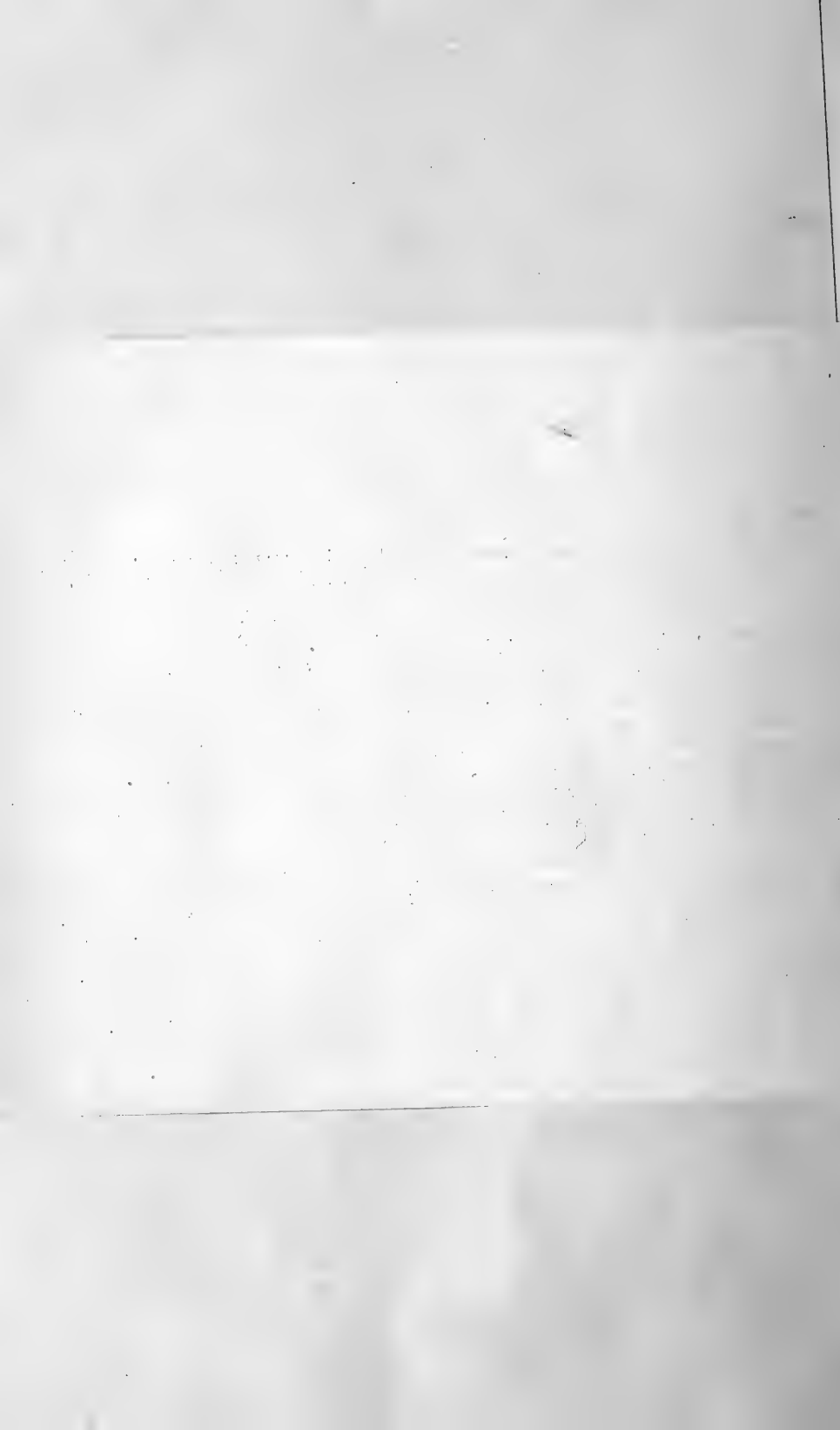


TABLE OF CONTENTS.

	Page.
SECTION A.—INTRODUCTION	1
1. <i>Object of the memoir</i>	1
1. Previous memoirs of the series	1
2. The commercial importance of the menhaden	1
3. The imperfect knowledge regarding this species	2
2. <i>Means employed in gathering information</i>	3
4. Circular issued. (See also Appendix A)	3
5. Letters of inquiry sent out	3
6. Personal studies made	3
3. <i>Sources of information</i>	3
7. Materials in the archives of the United States Fish Commission	3
8. Personal observations and the aid of individuals	3
9. Responses to the circular. (See also Appendices B and N)	4
10. Published accounts of the species. (See also Appendixes C and D)	4
11. The collections in the United States National Museum. (See also Appendix E)	5
4. <i>Sources of error which have been shunned</i>	5
12. The difficulty of obtaining exact information	5
13. Prejudices and superstitions	6
14. Inaccuracies of observation and statement	6
SECTION B.—THE NAMES OF THE MENHADEN	6
5. <i>Popular names</i>	6
15. Local names and usages	6
16. The geographical distribution of popular names	7
17. A table showing the geographical distribution of the popular names of the menhaden	7
18. Discrepancies in these names	9
19. The name of "menhaden" claimed to be the preferable one	10
20. Trade names of the menhaden and their liability to mislead	10
21. Origin of the popular names of the menhaden	10
22. "Pogy" and "menhaden"	11
23. "Hard-head" and "bony-fish"	12
24. "White-fish"	12
25. "Mossbunker"	12
26. "Alewife" and "oldwife"	13
27. "Bug-fish"	13
28. "Fat-back" and "yellow-tail"	14
29. The conflict of names among the American representatives of the herring family	14
6. <i>Zoological names</i>	15
30. Latrobe's description of <i>Clupea tyrannus</i> and the reasons for adopting this specific name. (See also Appendix E and Plate II)	15
31. Mitchell's description of <i>Clupea menhaden</i> . (See also Appendix E)	16
32. Rafinesque's <i>Clupea neglecta</i>	16
33. Belknap's <i>Clupea dura</i>	17
34. Mitchell's <i>Clupea sadina</i> and Gronow's <i>Clupea carolinensis</i>	17
35. <i>Brevoortia patronus</i>	17
36. Agassiz's <i>Clupanodon aureus</i>	17
37. Jenyns's <i>Clupea pectinata</i>	18
38. The generic relations of the species and Gill's genus <i>Brevoortia</i> . (See also Appendix G)	18
39. Revision of the American species of menhaden	18
SECTION C.—A DESCRIPTION OF THE AMERICAN SPECIES OF BREVOORTIA WITH ANATOMICAL AND PHYSIOLOGICAL NOTES	19
7. <i>Technical descriptions</i>	19
40. <i>Brevoortia tyrannus</i> (Latrobe), Goode	19
41. <i>Brevoortia patronus</i> , Goode	26
42. <i>Brevoortia pectinata</i> , Jenyns, Gill	30

	Page.
SECTION C.—A DESCRIPTION OF THE AMERICAN SPECIES OF BREVOORTIA, WITH ANATOMICAL AND PHYSIOLOGICAL NOTES—Continued.	
8. <i>Size</i>	31
43. Limits and relations of length and weight.....	31
44. Variations in individuals of the same schools	31
45. Rate of growth of young fish.....	32
46. Rate of growth of fish during their sojourn on the northern coast	33
9. <i>Color and other minor characteristics</i>	33
47. Color of northern fish	33
48. Color of southern fish	33
49. Axillary appendages	33
50. Arrangement and number of scales	34
10. <i>Internal organs</i>	34
51. The strainer in the mouth of the menhaden.....	34
52. The accessory branchial organ	34
53. The alimentary canal	34
54. The swim bladder.....	35
SECTION D.—GEOGRAPHICAL DISTRIBUTION AND THE MOVEMENTS OF THE SCHOOLS.....	35
11. <i>Geographical range</i>	35
55. Limits of range of <i>Brevoortia tyrannus</i> in 1877	35
56. Variations in northern limit in the past.....	35
57. Southern limit of range.....	36
58. Oceanic limits of range.....	36
59. The alleged occurrence of the true menhaden in the Gulf of Mexico.....	36
60. Range of other species of the genus.....	37
61. The alleged occurrence of a menhaden on the west coast of North America.....	37
12. <i>The arrival and departures of the schools</i>	38
62. Causes influencing arrival and departure	38
63. Material on hand for determining dates	38
64. Review of the dates of movement upon the entire coast.....	39
65. Stay of the schools on the coast of Florida.....	39
66. Stay on the coast of Georgia and South Carolina.....	39
67. Stay on the coast of North Carolina.....	40
68. Stay on the coast of Virginia and Chesapeake Bay.....	41
69. Stay in Delaware Bay.....	41
70. Stay on the coast of New Jersey	42
71. Stay at the eastern end of Long Island.....	42
72. Stay in Long Island Sound.....	42
73. Stay in Block Island Sound.....	43
74. Mr. Dudley's account of the movements of the schools on the coast of Eastern Connecticut	44
75. Stay in Narragansett Bay	44
76. Stay in Martha's Vineyard Sound.....	45
77. Table showing dates of appearance of menhaden at Waquoit Weir 1859-'72	46
78. Irregularity of the movements of the schools illustrated by the returns from Waquoit Weir	46
79. Stay of the schools on the south shore of Cape Cod	46
80. Stay in Cape Cod Bay.....	47
81. Stay about Cape Ann	48
82. Stay in the Gulf of Maine	48
83. Mr. Maddocks' account of the movements of the schools on the coast of Maine.....	50
13. <i>Migrations</i> . (See also Appendix F)	50
84. Migrations of fishes in general, and the causes.....	50
85. The influence of ocean temperatures upon the movements of the menhaden.....	52
86. General considerations as to the winter retreat of summer fishes.....	56
87. The theory of hibernation of sea fishes discussed with special reference to the mackerel	56
88. The theory of extended migrations discussed, with special reference to the mackerel.....	62
89. The arguments against extended migrations of the menhaden.....	65
90. The hypothesis of the oceanic sojourn of the menhaden.....	66
91. A criticism of Rimbaud's classification, with a new classification, by habits, of east-coast fishes.....	68
14. <i>The movements of the schools of menhaden</i>	70
92. Habits of the schooling fish.....	70
93. Movements of the schools to and from the surface.....	71

TABLE OF CONTENTS.

V

Page.

SECTION D.—GEOGRAPHICAL DISTRIBUTION AND THE MOVEMENTS OF THE SCHOOLS—Continued.

14. <i>The movements of the schools of menhaden</i> —Continued.	
94. Differences in the swimming movements of the menhaden and the mackerel.....	71
95. Birds attracted by the schools of fish.....	71
96. The influence of wind and weather.....	72
97. The movements of the herring as influenced by weather.....	72
98. The influence of the tides.....	74
15. <i>Alleged changes in the haunts and habits of the menhaden</i>	74
99. The allegation that the menhaden schools have been driven out to sea by the fisheries.	74
100. The opinion of Mr. Atkins upon this subject.....	76
101. The opinion of Mr. Maddocks.....	77
102. Recent changes in the northern limit of distribution.....	77

SECTION E.—ABUNDANCE OF THE MENHADEN COMPARATIVE AND ABSOLUTE.....

16. <i>Abundance in the past</i>	78
103. Abundance before 1850, from testimony of early writers.....	78
17. <i>Abundance in the present</i>	79
104. Abundance on the coast of Maine.....	79
105. Abundance on the coast of New Hampshire.....	81
106. Abundance on the coast of Massachusetts.....	81
107. Abundance on the coast of Rhode Island.....	84
108. Abundance on the coast of Connecticut.....	85
109. Abundance on the coast of New York.....	87
110. Review of the success of the fisheries in New England since 1865, by Mr. D. T. Church.....	88
111. Review of the success of the fisheries in Long Island Sound since 1870, by Mr. George W. Miles.....	88
112. Abundance on the coast of New Jersey.....	90
113. Abundance on the coast of Delaware.....	90
114. Abundance on the coast of Maryland and Virginia.....	90
115. Abundance on the coast of North Carolina.....	91
116. Abundance in Florida.....	92
117. Summation of evidence as to increase or decrease.....	92
18. <i>Abundance in the future</i>	93
118. Probability of future decrease.....	93

SECTION F.—FOOD OF THE MENHADEN.....

19. <i>Food</i>	93
119. Fishermen's ideas about the food of the menhaden.....	93
120. Fishermen's ideas about the manner of feeding.....	93
121. Examinations of stomach-contents.....	94
122. Inferences from their examinations.....	94
123. Professor Verrill's opinion as to the nutritive properties of bottom-mud.....	94
124. Explanation of the evolutions of the menhaden schools.....	95
125. Character of their food affecting the value of the fish for use for bait.....	95

SECTION G.—REPRODUCTION OF THE MENHADEN.....

20. <i>Studies of the parent fish</i>	95
126. Dissection of menhaden in Connecticut.....	95
127. Dissections of menhaden in Maine.....	96
128. Number of eggs in immature ovaries.....	96
129. The fact that no ripe milt or spawn has been observed by naturalists.....	97
130. A statement made by Mr. Atkins.....	97
21. <i>Studies of the young fish</i>	98
131. Appearance of the young south of Cape Cod.....	98
132. Powers of locomotion possessed by the young.....	98
22. <i>Inferences as to the time and place of spawning</i>	99
133. Inferences from studies of parent and young as to the times and places of spawning.	99
134. The opinions of fishermen upon this subject.....	99
135. The claim that menhaden spawn in southern rivers.....	100
136. A criticism of a statement made by Professor Hind.....	100
23. <i>The possibility of artificial culture</i>	100
137. The claim that menhaden can be artificially bred in the waters of the North.....	100

SECTION H.—THE ENEMIES AND FATALITIES OF THE MENHADEN.....

24. <i>Diseases of the menhaden</i>	101
138. Mortality of menhaden in the Merrimac River.....	101
25. <i>Parasites of the menhaden</i>	101
139. The crustacean parasite <i>Oymothoa prægustator</i>	101

	Page.
SECTION H.—THE ENEMIES AND FATALITIES OF THE MENHADEN—Continued.	
25. <i>Parasites of the menhaden—Continued.</i>	
140. Inferences to be drawn from the presence of these parasites.....	103
141. Other parasites.....	104
26. <i>Predaceous foes of the menhaden.</i>	104
142. The destructiveness of whales and dolphins.....	104
143. The destructiveness of sharks.....	105
144. The destructiveness of other fishes.....	105
145. Ravages of the bluefish and the bonito.....	106
146. The menhaden driven upon the shores.....	107
147. Captain Spindel's account of the ravages of the bluefish.....	108
148. Professor Baird's estimate of the destructiveness of the bluefish.....	108
149. An estimate of the number of menhaden annually consumed by predaceous fish.....	109
150. The place of the menhaden in nature.....	109
27. <i>Man and the fisheries</i>	110
151. Former allusions to the influence of the fisheries.....	110
152. Probability of future decrease.....	110
153. The alleged destructiveness of fishing.....	110
154. Comments upon these allegations.....	111
155. Professor Hind's unwarranted statements.....	112
156. The agitation in Maine concerning productive legislation.....	112
SECTION I.—THE MENHADEN FISHERIES.	
28. <i>The location of the fishing grounds</i>	113
157. Distribution of the fishing grounds.....	113
29. <i>Methods of capture</i>	113
158. Past and present methods contrasted.....	113
159. Difficulty experienced in obtaining statistics.....	114
160. Fisheries in Maine.....	114
161. Fisheries in Massachusetts.....	115
162. Fisheries in Rhode Island.....	115
163. Fisheries in Connecticut.....	116
164. Fisheries in New York.....	116
165. Fisheries in New Jersey, Delaware, and Maryland.....	116
166. Fisheries in Virginia and North Carolina.....	117
167. Fisheries in the South.....	117
30. <i>Apparatus of capture</i>	117
168. The purse-seines.....	117
169. The seine-boats.....	120
170. The sailing-vessels. (See also Appendix I).....	122
171. The steamers.....	123
31. <i>Certain requirements of purse-seine fishing</i>	123
172. Peculiarities of purse-seine fishing.....	123
173. The best time of day for using the purse-seine.....	124
32. <i>Descriptions of fishing scenes</i>	124
174. Fishing in Southern New England.....	124
175. Fishing on the coast of Massachusetts.....	125
176. Fishing on the coast of Maine.....	126
177. Gill-net fishing on the coast of Maine.....	128
178. Weir fishing for menhaden.....	129
179. Colonel Lyman's description of weir fishing for menhaden.....	129
180. Fishing for fat-backs in North Carolina.....	131
33. <i>The fisherman and the relation of the fisheries to the population of the neighboring shores</i>	131
181. The fishermen of Maine.....	131
182. The menhaden fishery and land industries.....	132
34. <i>Protective fishery laws</i>	132
183. Laws regulating the menhaden fishery of Maine.....	132
184. Laws regulating the menhaden fishery of Massachusetts.....	133
SUPER-SECTION.—ECONOMICAL VALUE AND APPLICATIONS OF THE MENHADEN..	
SECTION K.—THE MENHADEN AS A SOURCE OF FOOD.	
35. <i>The menhaden as a table fish.</i>	
185. Menhaden used fresh.....	135
186. Menhaden salted. (See also Appendix G).....	136
187. The demand for salt fish in seasons of scarcity of mackerel supplied by menhaden..	136
188. The question of allowance of drawback on salt.....	136

	Page.
SECTION K.—THE MENHADEN AS A SOURCE OF FOOD—Continued.	
36. <i>Food-preparations derived from the menhaden</i>	137
189. Menhaden preserved in oil, "American sardines".....	137
190. The qualities of "American sardines".....	138
191. Menhaden preserved in spices.....	138
192. Mr. Goodale's "Extract of Fish"—Methods of preparation and uses.....	139
193. Possible yield of "Extract of Fish".....	140
37. <i>The menhaden as a food for animals</i>	140
194. Menhaden scrap as a food for cattle and poultry.....	140
SECTION L.—THE MENHADEN AS A BAIT-FISH.....	141
38. <i>The use of menhaden for bait</i>	141
195. Menhaden as a bait for cod.....	141
196. Comparative value of menhaden and other bait.....	142
197. Menhaden as a bait for mackerel.....	142
198. Comparative value of herring and menhaden for toll-bait.....	143
199. The testimony of Canadian officers as to the value of menhaden bait.....	146
200. Testimony before the Halifax Commission regarding the greater value of menhaden bait.....	147
201. "Slivering" menhaden.....	147
202. The preparation of menhaden bait.....	147
203. The use of menhaden bait in coast fisheries.....	148
204. The extent of the bait-fisheries in Southern New England.....	148
205. Bait-fishing in the Merrimac River and in Salem Harbor.....	148
206. Estimate of the annual consumption of menhaden bait.....	149
207. Use of menhaden bait by the Georges Bank fleet.....	150
208. Use of menhaden bait by the Grand Banks fleet.....	150
209. Use of menhaden bait by the mackerel line fishermen.....	150
210. Use of menhaden bait by the Connecticut smacks.....	151
211. Use of menhaden bait by the New York halibut fleet.....	151
212. Annual sale of bait by the vessels of the Maine manufacturers.....	151
213. The Connecticut method of icing bait.....	152
214. The Cape Ann method of icing bait.....	152
215. Comparative value of different methods of icing bait.....	152
39. <i>Conflicts between bait-fishermen and manufacturers of oil</i>	155
216. Early feuds.....	155
217. Present aspects of the conflict in Maine.....	156
40. <i>Menhaden bait as an article of commerce, and the discussion of its value before the Halifax Commission of 1877</i>	156
218. The export of menhaden bait to Canada and Newfoundland as discussed before the Halifax Commission.....	156
219. Claims of Her Majesty's government.....	157
220. Reply of the agent of the United States.....	158
221. Reply in behalf of Her Britannic Majesty's government.....	159
222. Other references to the menhaden in the testimony and affidavits.....	160
223. The argument of Mr. Dana.....	161
224. Comments.....	161
SECTION M. THE MANUFACTURE OF OIL AND GUANO.....	161
41. <i>A history of the manufacture of menhaden oil</i>	161
225. The claims of Maine to the first discovery of menhaden oil.....	161
226. The claims of Connecticut and New York.....	162
227. The inception of the oil business in Maine.....	164
228. The dates of erection of factories in Maine.....	164
42. <i>The location of the oil-factories. (See also Appendix H)</i>	165
229. Factories in Maine.....	165
230. Factories in Massachusetts.....	165
231. Factories in Rhode Island.....	166
232. Factories in Connecticut.....	166
233. Factories in New York.....	167
234. Factories in New Jersey.....	168
235. Factories in Chesapeake Bay.....	168
236. Factories on the Southern coast.....	169
43. <i>Methods of manufacture</i>	169
237. The principles involved in the manufacture of oil.....	169
238. A description of processes employed in manufacture.....	170
239. A description of the processes employed in refining.....	170
240. The factory of George W. Miles & Co.....	171

	Page.
SECTION M.—THE MANUFACTURE OF OIL AND GUANO—Continued.	
43. <i>Methods of manufacture</i> —Continued.	
241. The factory of Judson, Terr & Co.	171
242. The factory of Joseph Church & Co.	172
243. The factory of Kenniston, Cobb & Co.	172
244. The factory at Napeague, N. Y.	173
245. The model of the factory of Joseph Church & Co.	174
246. The cost of an oil-factory.	174
247. Organization of the fishing gangs.	176
248. The advantages claimed for floating factories.	176
249. Mr. Goodale's improved method for extracting the oil.	177
250. Proposed chemical method.	178
251. Proposed mechanical methods.	178
44. <i>Value of fish to manufacturers</i>	178
252. Prices paid for fresh menhaden in different seasons.	178
253. Prices proportionate to amount of oil to be obtained from the fish.	180
254. Oil-yield of northern fish.	180
255. Oil-yield of southern fish.	183
256. Comparative oil-yield in different localities.	183
45. <i>Statistics of the manufacture of oil and guano</i>	184
257. Returns for the State of Maine.	184
258. Returns for the United States.	187
259. Comparative yield of oil from the menhaden and whale fisheries.	190
260. Comparative yield of nitrogen from the menhaden-factories and from the imports of bird-guano.	191
261. The associations of oil and guano manufacturers. (See also Appendices L and M).	191
46. <i>The uses of menhaden oil and the oil market</i>	191
262. The uses of menhaden oil.	191
263. The markets for menhaden oil.	192
264. The grades of oil.	192
265. The prices of oil. (See also Appendix K).	192
266. Reviews of the market for individual years.	193
SECTION N.—MENHADEN AND OTHER FISH, AND THEIR PRODUCTS, AS RELATED TO AGRICULTURE.—	
By W. O. Atwater. (See also Appendix O)	194
267. Introductory note.	194
47. <i>Menhaden in a fresh state used as a fertilizer</i>	195
268. Use among Indians and early colonists.	195
269. Use at beginning of present century and later.	196
270. Use at present day.	200
48. <i>Fish scrap as manure</i>	200
271. The inception of its use. Experience in Maine.	200
272. Experience in Connecticut. Mr. Clift.	201
273. Experience of Mr. Hall and Mr. Loveland.	203
274. Statements of Professor Cook of New Jersey.	205
275. Further experience in Maine. Messrs. Hinckley, Kenniston, Smith, and Captain Collins.	205
276. Other testimony.	208
49. <i>The manufacture of fish manures</i>	208
277. Early attempts at manufacture in Connecticut.	208
278. The De Molon process in Europe and in America.	208
279. Early manufacture in Rhode Island.	209
280. Manufacture in Canada.	210
281. Manufacture of cancerine in New Jersey.	210
282. Early manufacture in Maine.	210
283. Early manufacture in France.	212
284. Early manufacture in England.	213
285. Other European manufactures of fish manures.	213
286. The Norwegian fish-guano.	214
287. Manufacture of glue and removal of oil in preparation of fish guanos.	217
288. Success of fish-guano as a fertilizer in Europe.	218
289. The manufacture of fish fertilizers in the United States.	218
290. Kinds of fertilizers made from fish refuse.	219
291. Fish-guano; methods of manufacture and needs of improvement; statements of Professor Goessmann.	223
292. Statement of Mr. Maddocks; manufacture in Maine.	224

SECTION N.—MENHADEN AND OTHER FISH, AND THEIR PRODUCTS, AS RELATED TO AGRICULTURE—
Continued.

49. <i>The manufacture of fish manures—Continued.</i>	
293. Goodale's new process	224
294. Adamson's process	225
295. Immense waste of fish at present. Possibilities of future manufacture	226
296. "Acidulated fish" and "Fish and potash salts"	226
297. Manufacture of ammoniated superphosphates	227
50. <i>Chemical composition of menhaden and other fish and of fish manures</i>	228
298. Analyses of whole menhaden and of flesh and bones of whale	228
299. Analyses of fish fertilizers	229
300. Waste from faulty manufacture and use of fish fertilizers	230
51. <i>The use of fish fertilizers in agriculture</i>	230
301. Chemistry of plant nutrition	230
302. Essential ingredients of plant food	231
303. Exhaustion of soils by crops	231
304. Ingredients commonly lacking in worn-out soils, and hence most important in fertilizers	233
305. Principles to be observed in the manufacture and in the purchase of fertilizers	233
306. Composition, character, and uses of fertilizers in general	233
307. Explanation of chemical terms used in fertilizer analyses	234
308. Valuations of commercial fertilizers. (See also Appendix O)	235
309. Relative values of different fertilizers. Fish and Peruvian guano	244
310. Ways of improving fish manure; fermentation	247
311. Composting	247
312. Feeding to stock	248
313. Danger in using fish fertilizers alone	249
52. <i>Fish as food for domestic animals</i>	250
314. Laws of animal nutrition as shown by experiments. European researches	250
315. General principles of feeding, maintenance, and production	251
316. Digestion of foods by animals as tested by European experiments	254
317. What is essential to economy in feeding. Proportions of albuminoids and carbohydrates	255
318. Composition and valuations of various food materials. German tables	256
319. Early experience in use of fish as food for stock. Feeding cattle on fish in Massachusetts	258
320. Experience of Mr. Lawes in England on fish as food for swine	258
321. Other European experience	259
322. Success of Maine farmers in feeding sheep on fish	259
323. Experiment of Professor Farrington on fish scrap vs. corn-meal for sheep	260
324. European experiments on digestion and nutritive value of fish	263
325. General conclusions	264
53. <i>Recapitulation</i>	265
326. Fish as manure	265
327. Fish as food for stock	266
328. The loss to our agriculture from waste of fish. The evil	266
329. The remedy	266
APPENDIX A.—Circular relating to statistics of the menhaden fishery	268
APPENDIX B.—List of correspondents from whom contributions have been received	271
APPENDIX C.—Bibliography of literature relating to the menhaden	274
APPENDIX D.—Extracts from writings of ichthyologists relating to the menhaden	279
A drawing and description of the <i>Clupea tyrannus</i> and <i>Oniscus prægustator</i> . By B. H. Latrobe. < Transactions of American Philosophical Society, Vol. V, 1802, pp. 78-80.	279
From Mitchell's "Fishes of New York." < Transactions of Literary and Philosophical Society of New York, 1815, p. 453	282
From Storer's "History of the Fishes of Massachusetts," 1867, p. 168.	283
From Dekay's "Zoology of New York, Fishes," 1842, p. 259	284
From Cuvier and Valenciennes's "Histoire Naturelle des Poissons," XX, p. 424.	286
From Uhler and Lugger's "List of the Fishes of Maryland," 1876, p. 133.	287
From Perley's "Report on the Sea and River Fisheries of New Brunswick," 1852, p. 208.	287
From Gray's Catalogue of Fish, by Gronow, 1854, p. 140	287
From Günther's "Catalogue of Fishes in the British Museum," VII, p. 436.	288
APPENDIX E.—Catalogue of specimens in the United States National Museum illustrating the history of the menhaden	289

	Page.
APPENDIX F.—Tables of ocean temperatures for certain points on the east coast of the United States	291
TABLE I.—Table of surface temperatures, March, 1876, to February, 1877	291
TABLE II.—Table of bottom temperatures, March, 1876, to February, 1877	292
TABLE III.—Table of mean temperatures of surface and bottom, March, 1876, to February, 1877	293
TABLE IV.—Table of mean temperatures of surface and bottom, March, 1877, to February 28, 1878	294
APPENDIX G.—Table showing comparative amounts of menhaden, mackerel, shad, and alewives inspected in the State of Massachusetts, 1804 to 1877	295
APPENDIX H.—List of manufacturers of menhaden oil and guano. (Compiled by Mr. Jasper Pryer)	296
APPENDIX I.—Partial list of vessels employed in the menhaden fishery	297
Steamers	297
Sailing-vessels	298
APPENDIX K.—Prices-current of menhaden oil and review of the markets. [From the "Oil, Paint, and Drug Reporter"]	299
Prices-current for the years 1871, 1872, 1873, 1874, 1875, 1876, 1877	299
Weekly review of the market for the years 1871, 1872, 1873, 1874, 1875, 1876, 1877	304
APPENDIX L.—Proceedings of the United States Menhaden Oil and Guano Association	358
First annual meeting, 1874	358
Second annual meeting, 1875	359
Third annual meeting, 1876	360
Fourth annual meeting, 1877	363
Fifth annual meeting, 1878	365
APPENDIX M.—Annual reports of menhaden oil and guano manufacturers in the State of Maine	368
First annual report, 1873	368
Second annual report, 1874	369
Third annual report, 1875	370
Fourth annual report, 1876	371
Fifth annual report, 1877	372
APPENDIX N.—Statements of correspondents	373
1. Statement of W. H. Sargent, Castine, Me., January 26 and December 28, 1874	373
2. Statement of J. C. Condon, Belfast, Me., communicated by Marshall Davis, deputy collector, Belfast, Me.	375
3. Statement of R. A. Friend, Brooklin, Me.	377
4. Statement of John Grant, Matinicus light-station, Matinicus Rock, Me., March 31, 1874	378
5. Statement of Benjamin F. Brightman, Waldoborough, Me., March 18, 1874	379
6. Statement of L. Maddocks, Booth Bay, Me., December 25, 1877	382
7. Statement of G. B. Kenniston, Booth Bay, Me., February 14, 1874	382
8. Statement of Judson Tarr & Co., Rockport, Mass., and Booth Bay, Me., January 23, 1874	385
9. Statement of Mrs. B. Humphrey, keeper of Monhegan Island light, Monhegan Island, Me., February 4, 1874	387
10. Statement of J. Washburn, jr., Portland, Me., February, 1874	388
11. Statement of Chandler Martin, keeper of Whale's Back light, Whale's Back, N. H., February 23, 1874, and January 9, 1875	390
12. Statement of Thomas Day, keeper of Seguin light, Parker's Head, Me.	390
13. Statement of William S. Sartell, Pemaquid light-station, Bristol, Me., February 1, 1874	391
14. Statement of Alden H. Jordan, keeper of Baker's Island light, Cranberry Isles, Me., December 29, 1873, and February 9, 1874	391
15. Statement of Washington Olin, keeper of Pond Island light, near Booth Bay, Me., February 18, 1874	393
16. Statement of an unknown correspondent, Gloucester, Mass., March 28, 1874	393
17. Statement of Capt. F. J. Babson, collector of customs, Gloucester, Mass.	395
18. Statement of Simeon Dodge, Marblehead, Mass.	399
19. Statement of Eben B. Phillips, Swampscott, Mass., January 21, 1874	401
20. Statement of Thomas Loring, collector, Plymouth, Mass., January 24, 1874, and March 20, 1875	403
21. Statement of William Atwood, light-house keeper, Plymouth, Mass., February 23, 1874	404
22. Statement of Heman S. Dill, Wel fleet, Mass., January 9, 1875	405

TABLE OF CONTENTS.

XI

Page.

APPENDIX N.—Statements of correspondents—Continued.

23. Statement of David F. Loring, Highland light-station, North Truro, Mass., March 2, 1874	407
24. Statement of David F. Loring, Cape Cod light-station, North Truro, Mass., February 23, 1875	409
25. Statement of Josiah Hardy, 2d, Chatham, Mass., February 17, 1874, and January 9, 1875	410
26. Statement of Alonzo Y. Lothrop, Hyannis, Mass., February 18, 1874, and January 1, 1875	412
27. Statement of William S. Allen, Nantucket, Mass., January, 1875	413
28. Statement of R. C. Kenney, Nantucket, Mass., January 21, 1874	414
29. Statement of C. B. Marchant, collector of customs, Edgartown, Mass., January 13, 1875	416
30. Statement of Jason Luce & Co., North Tisbury, Mass., January 6, 1875	417
31. Statement of Gallup, Morgan & Co., Groton, Conn., December 28, 1877	417
32. Statement of Luce Brothers, East Lyme, December 4, 1877	418
33. Statement of Daniel T. Church, Tiverton, R. I.	418
34. Statement of E. T. De Blois, Portsmouth, R. I., November 26, 1877	425
35. Statement of H. D. Ball, New Shoreham, R. I., January 11, 1875	425
36. Statement of Henry W. Clark, keeper of Southeast light-house, Block Island, R. I., February 6, 1875	425
37. Statement of J. S. Crandall, Watch Hill, R. I., February 20, 1874, and January 1, 1875	427
38. Statement of William H. Potter, Mystic River, Conn., January 27, 1874	428
39. Statement of John Washington, Mystic, Conn., December 30, 1874	430
40. Statement of Leander Wilcox, Mystic Bridge, Conn., January 15, 1875	431
41. Statement of Samuel C. Beebe, Cornfield Point light-vessel No. 12, Saybrook, Conn., January 6, 1875	432
42. Statement of R. E. Ingham, Saybrook light-house, Saybrook, Conn., March 17, 1874 ..	433
43. Statement of J. L. Stokes, Westbrook, Conn., February 25, 1875	435
44. Statement of F. Lillingston, Stratford, Conn.	435
45. Statement of B. Lillingston, Stratford, Conn., February 23, 1874	437
46. Statement of George W. Miles, Milford, Conn., January 17, 1874	437
47. Statement of W. S. Havens, Sag Harbor, N. Y., January 1, 1875	441
48. Statement of J. Norrison Raynor, agent of Sterling Company, Greenport, December 20, 1877	443
49. Statement of Hawkins Brothers, Jamesport, N. Y., February 25, 1875	443
50. Statement of Benjamin H. Sisson, Greenport, R. I., January 29, 1874	445
51. Statement of David G. Vail, River Head, Long Island, March 20, 1875	447
52. Statement of Joseph Whaley, Point Judith light, Point Judith, R. I., December 28, 1874	449
53. Statement of A. G. Wolf, Absecom light, Atlantic City, N. J., March 6, 1874	450
54. Statement of Albert Morris, Somers Point, N. J., January 12, 1875	451
55. Statement of D. E. Foster, Cape May light-house, N. J., February 15, 1875	453
56. Statement of A. A. Owens, Philadelphia, Pa., March 31, 1875	453
57. Statement of James H. Bell, Mispillion River, Delaware Bay, January 23, 1875	454
58. Statement of Benjamin Tice, Maurice River light, January 11, 1875	457
59. Statement of Joseph B. Benson, Bombay Hook, Del., January 18, 1875	457
60. Statement of Hance Lawson, Crisfield, Md., January 22, 1874	458
61. Statement of Isaac D. Robbins, Hog Island, February 21, 1874	460
62. Statement of J. L. Anderton, Apateague Island, Va., January 12, 1875	460
63. Statement of G. Henry Seldon, Kinsale, Westmoreland County, Va., August, 1874 ..	461
64. Statement of Henry Richardson, Cape Henry, February 9, 1874	464
65. Statement of C. G. Manning, Edenton, N. C., January 6, 1875	465
66. Statement of A. W. Simpson, jr., Cape Hatteras, N. C., April 15, 1874	465
67. Statement of A. W. Simpson, jr., Cape Hatteras, N. C., January 20, 1875	470
68. Statement of A. W. Simpson, jr., Cape Hatteras, N. C., January 25, 1875	471
69. Statement of Wallace R. Jennett, Cape Hatteras, N. C., February 26, 1874	474
70. Statement of A. C. Davis, Beaufort, N. C., February 14, 1874, and January 27, 1875 ..	475
71. Statement of W. T. Hatsel, Body's Island, N. C., March 4, 1874, and February 23, 1875 ..	477
72. Statement of W. A. Harn, Morris Island, S. C., January 21, 1875	478
73. Statement of Patrick Conner, Daufuskie Island light, S. C., March 15, 1875	478
74. Statement of George Gage, Beaufort, S. C., January 20, 1874	479
75. Statement of Joseph Shepard, Saint Mary's, Ga., March 30, 1874, and January 28, 1875 ..	479
76. Statement of J. F. Hall, Brunswick, Ga., April 11, 1876	481

	Page.
APPENDIX N.—Statements of correspondents—Continued.	
77. Statement of Capt. David Kempf, Yellow Bluffs, Fla., February 10, 1875.....	481
78. Statement of Charles Koch, Jacksonville, Fla., January 15, 1874	482
79. Statement of D. P. Kane, Matagorda, Texas, March 1, 1874.....	483
APPENDIX O.—Miscellaneous items regarding the use of fish for manure.....	483
1. The earliest printed account of the use of menhaden for a fertilizer, being an extract from an article by Ezra l'Hommedieu, 1801.....	483
2. Letter from C. A. Goessman on the agricultural value of menhaden fertilizers.....	485
3. A description of the factory of the Pacific Guano Company at Wood's Holl, Mass.....	487
4. The Cumberland Bone Company's works.....	491
5. The Quininiac Fertilizer Company's works.....	492
6. The Crowell Manufacturing Company	493
7. Method of calculating costs of valuable ingredients of fertilizers. By W. O. Atwater.	495
8. Improved methods of drying fish-scrap.....	502
APPENDIX P.—Exports of menhaden oil, from the port of New York, from January, 1875, to July, 1878.....	503
APPENDIX Q.—Supplementary works, September 23, 1878.....	506
1. An early allusion to the "fat-back" on the Southern coast	506
2. Departure of the schools in the fall	506
3. The spawning grounds of the menhaden.....	507
4. Menhaden fishing on a Long Island steamer. By Ernest Ingersoll	508
5. The manufacture of sardines from menhaden	512
6. Small oil-trying in Maine, 1860.....	513
7. The use of fish for manure by the early colonists of Massachusetts	514
8. A fish fertilizer company in Boston, 1860.....	514
Explanation of plates	515
Alphabetical index.....	519

I.—THE NATURAL AND ECONOMICAL HISTORY OF THE AMERICAN MENHADEN.

BY G. BROWN GOODE.

A—INTRODUCTION.

1.—OBJECT OF THE MEMOIR.

Previous memoirs in this series.

1. In the first report of the Commissioner of Fish and Fisheries,* was commenced the publication of a series of memoirs upon the important fishes of the United States. Professor Baird inaugurated the work with two treatises from his own pen with the following titles:

I. THE SCUP. *Stenotomus argyrops*, (Linn.) Gill.†

II. THE BLUEFISH. *Pomatomus saltatrix*, (Linn.) Gill.‡

The present memoir is the third of this series. The work of preparing it was assigned to me in September, 1874. I have tried to make it exhaustive, including everything known about the subject, and statistics up to January 1, 1878. There are still, however, many questions which need further study, for the subject is not at all well understood. I send the manuscript to the printer with reluctance, hoping at some time to resume the study of the many unsolved problems.

The commercial importance of the menhaden.

2. The menhaden has grown greatly in favor within a comparatively short time. Twenty-five years ago, and before, it was thought to be of very small value. A few millions were taken every year in Massachusetts Bay, Long Island Sound, and the bays of New Jersey. A small portion of these were used for bait; a few barrels were occasionally salted in Massachusetts to be exported to the West Indies. Large quantities were plowed into the soil of the farms along the shores, stimulating the crops for a time, but in the end filling the soil with oil, parching it, and making it unfit for tillage. Since that time manifold uses have been discovered. As a bait-fish, this is found to excel all others. For many years much the greater share of all our mackerel have been caught by its aid, while our cod and halibut fleet use it, rather than

* United States Commission of Fish and Fisheries. | — | Part 1. | — | Report | on the | Condition of the Sea Fisheries | of the | South Coast of New England | in | 1871 and 1872. | By | Spencer F. Baird, | Commissioner. | — | With supplementary papers. | — | Washington: | Government Printing Office. | 1873. 8vo., pp. xlvii, 852, 40 plates, 2 maps.

† Op. cit., pp. 223-235.

‡ Op. cit., pp. 235-252.

any other fish, when it can be procured. The Dominion mackerel fleet buy it in quantity, and its value has been thought an important element in framing treaties between our government and that of Great Britain. As a food resource it is found to have great possibilities. Many hundreds of barrels are sold, salted, in the West Indies, while thousands of barrels are salted down every year for domestic use by families living near the shore. In many sections the fresh fish are sold in the market. Within five years has sprung up an important new industry, which consists in packing these fish in oil, after the manner of sardines, for home and foreign consumption. The discovery made by Mr. Goodale, that from these fish may be extracted, for the cost of carefully boiling them, a substance possessing all the properties of Liebig's "extract of beef," opens up a vast field for future development. As a food for domestic animals, in the shape of "fish meal," there seems also to be a broad opening. As a source of oil the menhaden is more important than any other marine animal: its annual yield usually exceeds that of the whale (from American fisheries) by about 200,000 gallons, in 1874 not falling far short of the aggregate of all the whale, seal, and cod oil made in America. The refuse of the oil-factories supplies a material of much value for manures: as a base for nitrogen it enters largely into the composition of most of the manufactured fertilizers. The amount of "ammonia" derived from this source in 1875 was estimated to be equivalent to that contained in 60,000,000 pounds of guano from Peru, the gold value of which would not be far from \$1,920,000. In 1876 the yield of the menhaden fishery was more than twice that of any other carried on by the fishermen of the United States. In the value of its products it was surpassed only by the cod and mackerel fisheries.*

Imperfect information regarding the species.

3. At the time of beginning the investigation, the results of which are partially detailed in this memoir, comparatively little was known about the menhaden. The species had been described or referred to in most of the books on the ichthyology of North America, and in

* The following table of estimates shows in a general way the relative values of the fisheries in 1876:

Fisheries.	Yield in pounds.	Value.
Menhaden fishery	462,000,000	\$1,657,790
Cod fishery	215,000,000	4,825,540
Mackerel fishery	49,000,000	2,375,262
Fisheries of the great lakes (1872)	32,250,000	1,600,000
Salmon fishery of Columbia River	30,000,000	2,500,000
Halibut fishery	22,000,000	1,546,240
Shad fishery (estimate)	20,000,000	1,060,000
Scup fishery	7,760,000	504,400
Bluefish fishery	7,668,000	424,000
Swordfish fishery	1,500,000	165,000
Bonito fishery	2,200,000	143,000
Squeteague fishery	1,600,000	138,200
Flounders fishery	1,827,000	109,620
Herring fishery (partly in British waters)	27,933,500	507,977
Whale fishery		2,850,000
Oyster fishery		25,000,000

some of the general ichthyological treatises. Mitchill, Storer, and Dekay had given imperfect figures. Allusions were made to its economical value by some of the books mentioned, and in agricultural and statistical works occasional reference had been made to its importance as a manure. Up to the present day the reports of the Commissioner of Agriculture have barely referred to the existence of this source of fertilizing material. Many persons engaged in fishing or manufacturing had a comprehensive knowledge of some parts of its history, but these had never been written or printed. There was no adequate account of this fish accessible to the student. Recognizing the necessity of supplying this need, the Commissioner of Fisheries chose this species as the next to be studied.

2.—MEANS USED TO GATHER INFORMATION.

4. A circular was issued, December 20, 1873, requesting information upon many points in the history of the menhaden, and propounding fifty-eight questions for the guidance of those disposed to aid in the investigation.* This was distributed to manufacturers, fishermen, and all known to be interested in the fisheries. Through the courtesy of the Secretary of the Treasury and the Chairman of the Light-House Board it was also sent to all collectors of customs and light-house keepers on the Atlantic and Gulf of Mexico. A second edition of this circular was issued in 1874.

5. Personal letters have been addressed to nearly all the intelligent respondents to the circular, and to many others, asking information upon uncertain points.

6. The attention of the marine branch of the Fish Commission has for four seasons been especially directed to the menhaden, especially with a view to learning about its food and its habits of spawning.

3.—SOURCES OF INFORMATION.

7. At the beginning of this work Professor Baird gave me five or six pages of closely-written manuscript containing his own observations made during five or six summers on the coast of New England. These have been of the greatest importance, and my own work has been little more than that of expanding and carrying out the suggestions there made. I have also made use of notes made by Professors Smith and Verrill, and by Mr. Vinal N. Edwards, and the testimony taken by Professor Baird, in 1872.

Personal observations and aid of individuals.

8. While with the Commission at Eastport, Me., in 1872; Portland, Me., in 1873; at Noank, Conn., in 1874; at Wood's Holl, Mass., in 1875; and at Salem, Mass., and Halifax, Nova Scotia, in 1877, I used every opportunity to study this fish. I have also had opportunities of observing it at the mouth of the Saint John's River, Florida; in the Potomac, at sev-

* This circular is reproduced in Appendix A.

eral of the fisheries; at Greenport, N. Y., and Provincetown, Mass. In October, 1877, I visited Mr. H. L. Dudley, at his works on Pine Island, Connecticut, and there had an excellent opportunity of observing the operations of an oil and guano factory. A similar opportunity was afforded me by the officers of the Pacific Guano Company at Wood's Holl. Here I was enabled, by the aid of Mr. Herbert Gill, stenographer, to obtain very full statistics.

In addition to the circulars, over two hundred personal letters have been written. In almost every case full and satisfactory replies were received. The following gentlemen have been particularly obliging:—

Mr. H. L. Dudley, Secretary of United States Menhaden Oil and Guano Association, New Haven, Conn.; Mr. D. T. Church, Tiverton, R. I.; Prof. C. A. Goessman, Massachusetts Agricultural College, Amherst, Mass.; Mr. E. H. Jenkins, Connecticut Agricultural Experiment Station, New Haven, Conn.; Hon. S. L. Goodale, Saco, Me.; Mr. E. G. Blackford, New York City; Mr. Barnet Phillips, New York City; Mr. W. O. Allison and Mr. Jasper Pryer, New York City.

I am also under obligation to Prof. W. O. Atwater, of Wesleyan University, who has written the portion relating to agriculture; to Mr. H. L. Dudley, for advice and criticism; and to Mr. Herbert A. Gill of the Smithsonian Institution, Mr. William Jameson, and Mr. Walter P. Stoddard, of Wesleyan University, for aid in preparing the manuscripts for the press. My associate, Dr. T. H. Bean, has worked with me in studying the specific characters of the two species of *Brevoortia*. The drawings are by Mr. J. H. Emerton, of Salem, and Mr. H. L. Todd, of Washington. Electrotypes have been obtained from the "American Agriculturist," from George W. Miles & Co., the American Sardine Company, and the Pacific Guano Company.

Responses to the circular of inquiry.

9. The circular of inquiry elicited responses from the correspondents named below, in Appendix B, most of which were carefully prepared, and in many cases give the results of years of observation. In Appendix N will be found these responses in full.

Published accounts of the species.

10. In discussing the history of the name and classification of the *Brevoortia tyrannus* and its allies, allusion is made to various books, and so incidentally under other heads. In Appendix C will be found a complete bibliography of the subject, containing about one hundred and forty citations. Many of these authorities have been quoted in the text. Some of the most important descriptions have been reproduced in Appendix D.

Most of the work on this report was done in the winter of 1874-'75. Since that time two pamphlets have been published, containing very valuable contributions to the knowledge of the menhaden. From these

I have derived much information and have quoted freely. The first was the report of Messrs. Boardman and Atkins.* The most recent contribution is that prepared by Mr. Luther Maddocks, under the auspices of the Maine association.† This is a most interesting little essay, especially valuable for the complete statistics of fisheries and manufactures in Maine, and the account of the relations of the fisheries to the fishermen, the shore population, and the property of the adjoining towns.

The collections of the United States National Museum.

11. The collections of the Fish Commission, deposited in the National Museum, contain over one hundred bottles of menhaden in alcohol, including probably over one thousand specimens, from many localities, with photographs and casts. A list of these is given in Appendix E.

There is also a model of the menhaden fishing steamer "Leonard Brightman" with seine-boats (No. 25824, Ethn. Cat.), made by Joseph Lawler, of Bristol, Me.; models of the Cape Ann seine-boat (No. 25800), with fittings, and the Cape Ann seining-dory (No. 25827), from Higgins and Gifford, of Gloucester; a full series of "fittings" for seine-boats, manufactured by Wilcox and Crittenden, of Middletown, Conn., including "cleats" (No. 25177), "steering rowlocks with stern-sockets" (Nos. 25113-'14), "oar-holders" of old and new models (Nos. 25171-'72), "davit-iron" (No. 25166), "tow-iron" (No. 25167), and "tow link and hook" (No. 25168); a pump box and haft for seine-boat (No. 29499) from Andrew Kennedy, of Provincetown. The Pacific Guano Company is represented by a large model of their works, the same which was exhibited in their pavilion at the Exposition grounds in Philadelphia, and there is a very satisfactory model of the oil factory of Joseph Church & Co., at Bristol, Me. (No. 26899), made by Joseph Lawler.

4.—SOURCES OF ERROR WHICH HAVE BEEN SHUNNED.

The difficulty of obtaining exact information.

12. It has been necessary to make allowances for many inaccuracies of statement on the part of our correspondents. Some of them, having

*The | Menhaden and Herring Fisheries | of Maine | as sources of fertilization. | A Report made to the Maine Board of Agriculture | By Samuel L. Boardman, Secretary of the Board | and | Charles G. Atkins, formerly Fish Commissioner of Maine, | 8vo. 1875, pp. 67.

Under direction of the Maine Board of Agriculture, Mr. Samuel L. Boardman, its secretary, visited in 1874 and 1875 nearly all the manufacturing establishments in Maine, thoroughly investigating their operations. The account of the agricultural uses of fish is the most complete which has yet been published (pp. 34-67). Mr. Charles G. Atkins, formerly commissioner of fisheries for the State of Maine, and for several years in charge of the salmon-hatching establishment at Bucksport, contributed a very thorough study of the habits of the fish (pp. 1-33).

† The Menhaden fishery of Maine | with statistical and historical details | its | relations to Agriculture | and as a | direct source of human food | — | New processes, products, and discoveries | — | Published by the | Association of the Menhaden Oil and Guano Manufacturers of Maine | Press of B. Thurston & Company, Portland, 1878. 8vo. p. 46, 4 cuts.

been unable to obtain exact information, have ventured to guess at what they did not really know from experience. I do not think that there has been intentional misrepresentation or any effort to withhold information. There being no ulterior object, such as future legislation, in collecting this information, there has been no temptation to concealment; still the testimony has been partly that of interested persons. The most fair and honorable men, however careful may be their observations, are involuntarily influenced by preconceived opinions or by considerations of personal interest, and, even if it were possible to secure unprejudiced opinions, these necessarily would express only part of the truth. Then, too, the movements of fishes are so capricious, the opportunities of observation so few and so imperfect, that satisfactory results can, in most cases, be reached only after years of constant study.

Prejudices and superstitions.

13. Some curious prejudices and fancies have been encountered among the fishermen. These refer chiefly to the time and manner of spawning, the character of the eggs, the nature of their food, and the relation of the fish to its peculiar parasite.

Inaccuracies of observation and statement.

14. There has been some difficulty in eliminating unreliable data from the great mass of facts contributed by correspondents. This, however, has not been so great as was apprehended at the beginning of the work, since a knowledge of the beliefs and traditions current among seafaring men renders it easy to detect many of the errors at once. The concurrent testimony of a number of reliable correspondents has been thought sufficient to establish points in question: when possible, these have been investigated personally, to render their establishment doubly certain. A large proportion of the communications received have evidently been prepared with much care. It is believed that many facts hitherto unrecorded have been brought to light by this investigation. All communications are given in full in Appendix N. This has been done both to show the character of the testimony upon which this history has been founded, and to put upon record many facts which, while not directly connected with the subject under consideration, are nevertheless of value to the student of the fisheries.

B.—THE NAMES OF THE MENHADEN.

5.—POPULAR NAMES.

Local names and usages.

15. *Brevoortia tyrannus* has at least thirty distinct popular names, most of them limited in application within narrow geographical boundaries. To this circumstance may be attributed the prevailing ignorance regard-

ing its habits and migrations, which has perhaps prevented the more extensive utilization of this fish, particularly in the Southern States. It accounts for the extraordinary blunder of the compilers of the fishery statistics of the census of the United States for 1870, in which the oils produced from the whitefish of the great lakes (*Coregonus albus*) and the whitefish of Connecticut are classed as identical, a blunder which is followed by a number of others of the same character and quite as certain to mislead. The discrepancy of local names also enables us to understand how the extensive manufacturing interests and fisheries connected with this fish have gradually sprung up, little noticed save by those directly interested in the business.

The geographical distribution of the popular names.

16. In Maine and Massachusetts the name "pogy" is almost universally in use, though in the vicinity of Cape Ann it is partially replaced by "hard-head" and "hard-head shad." The name "menhaden" is exclusively applied in Southern Massachusetts, the Vineyard Sound, Buzzard's Bay, and Narragansett Bay, where it appears to have originated. From the eastern boundary of Connecticut to the mouth of the Connecticut River the name "bony-fish" predominates, while in the western part of the State the species is usually known as the "white fish." In the waters of New York the usage of two centuries is in favor of "mossbunker," a name which also holds throughout New Jersey. In Delaware Bay, the Potomac, and Chesapeake Bay other variations are found in "alewife" and "greentail." Virginia gives us "bug-fish" in its various forms, while in North Carolina we first meet the name of "fat-back," which is more or less prevalent as far south as the Saint John's River, Florida. In all the Southern States, especially in the vicinity of Beaufort, N. C., the names "yellow-tail" and "yellow-tailed shad" are occasionally heard. I am informed that in the Indian River, Florida, the fish is occasionally called the "shiner" and the "herring."

17. The following table gives the usage at a number of points on the coast chosen to exhibit most clearly the geographical distribution of the popular names of *Brevoortia tyrannus*:

Passamaquoddy Bay, Me	Pogy; Bony-fish.
Castine, Me	Pogy; Menhaden.
Belfast, Me	Pogy.
Brooklin, Me	Pogy.
Cranberry Isles, Me	Pogy.
Sargentsville, Me	Pogy.
Matineus Rock, Me.....	Pogy; Porgie; Menhaden.
New Harbor, Me.....	Menhaden.
Manhegin Island, Me	Pogy.
Damariscotta, Me.....	Pogy; Mossbunker.
Pemaquid, Me	Pogy; Menhaden.

Muscongus, Me.....	Pogy; Menhaden.
Boothbay, Me	Pogy; Menhaden.
Bristol, Me	Pogy; Menhaden.
Round Pond, Me.....	Pogy.
Waldoboro', Me.....	Pogy.
Pond Island, Me.....	Pogy; Menhaden.
Portland, Me	Pogy.
Pine Point, Me	Pogy.
Portsmouth, N. H	Pogy.
Rockport, Mass	Pogy; Menhaden.
Gloucester, Mass	Pogy; Porgie; Menhaden; Hardhead.
Salem, Mass.....	Pogy; Hardhead.
Marblehead, Mass	Hardhead; Pogy; Menhaden.
Swampscott, Mass	Pogy; Menhaden.
Plymouth, Mass.....	Pogy; Menhaden.
Wellfleet, Mass	Pogy; Hardhead.
Truro, Mass	Pogy.
Provincetown, Mass.....	Pogy; Menhaden.
Chatham, Mass	Pogy; Menhaden.
Hyannis, Mass	Pogy; Menhaden.
Nantucket, Mass.....	Pogy; Poggie; Menhaden.
Edgartown, Mass	Menhaden.
North Tisbury, Mass.....	Menhaden.
Woods Holl, Mass	Menhaden.
New Bedford, Mass	Menhaden.
Tiverton, R. I.....	Menhaden.
Newport, R. I.....	Menhaden; Mossbunker.
New Shoreham, R. I., (Block Isl'd)	Menhaden.
Point Judith, R. I.....	Menhaden.
Watch Hill, R. I.....	Bony-fish.
Stonington, Conn	Bony-fish.
Mystic, Conn	Bony-fish.
Noank, Conn	Bony-fish.
New London, Conn.....	Bony-fish.
Groton, Conn	Bony-fish.
Lyme, Conn	Bony-fish.
Saybrook, Conn.....	Bony-fish; White-fish
Westbrook, Conn	White-fish.
Guilford, Conn	White-fish.
New Haven, Conn.....	White-fish; Menhaden.
Milford, Conn.....	White-fish; Menhaden.
Stratford, Conn.....	White-fish; Menhaden; Bunker.
Bridgeport, Conn	White-fish.
Norwalk, Conn	White-fish.
Montauk Point, N. Y.....	Bony-fish.
Napeague, N. Y.....	Bony-fish.

Jamesport, N. Y.....	Mossbunker; Menhaden.
Sag Harbor, N. Y.....	Mossbunker.
New York City and vicinity....	Mossbunker.
Port Monmouth, N. J.....	Mossbunker.
Tuckerton, N. J.....	Mossbunker.
Atlantic City, N. J.....	Mossbunker.
Somers Point, N. J.....	Mossbunker.
Cape May, N. J.....	Bony-fish.
Bombay Hook, Del.....	Mossbunker; Oldwife; Bug-fish.
Mispillion River, Delaware.....	Old-wife.
Maurice River.....	Mossbunker; Old-wife Chebog.
Hog Island.....	Mossbunker; Ell-wife.
Tangier Sound, Maryland.....	Alewife.
Pocomoke Sound, Maryland.....	Alewife.
Marlboro', Md.....	Alewife.
Nanjemoy, Md.....	Alewife.
Point Lookout.....	Alewife.
Apategue Island, Va.....	Alewife.
Washington, D. C.....	Alewife; Bug-fish.
Potomac River.....	Alewife; Bug-fish; Greentail.
York River, Va.....	Alewife; Bug-head.
Rappahannock River, Virginia..	Old-wife; Wife; Bug-head.
Cape Henry, Virginia.....	Alewife; Bony-fish.
Edenton, N. C.....	Bug-fish.
Cape Hatteras.....	Fat-back; Menhaden.
Beaufort, N. C.....	Fat-back; Yellow-tail shad.
Body's Island, N. C.....	Fat-back.
Fort Macon, N. C.....	Fat-back.
Charleston, S. C.....	Menhaden; Mossbunker.
Saint Mary's, Ga.....	Menhaden.
Saint John's River, Florida.....	Menhaden; Mossbunker; Fat-back.

Discrepancies in the popular names.

18. These names are not separated in their distribution by sharply-defined boundaries. Still, as a glance at the table will show, the *habitat*, if that term may be legitimately used, of each local appellation appears to be clearly marked. Where there is a discrepancy it can usually be explained. For instance, the general use of the name "menhaden" in the vicinity of Boothbay, Me., is due to the presence of a large number of fishermen and laborers from Rhode Island who carry on the oil-factories in that region. In the same way the name "bony-fish" has been naturalized at Montauk Point and Napeague, N. Y. The factories in that neighborhood are owned by firms in Eastern Connecticut, and the Connecticut "bony-fish fleet" has a favorite cruising ground in the waters of Eastern Long Island. The names "menhaden" and "mossbunker" have been introduced into Florida by northern fishermen, who

prosecute the winter shad fisheries on the Saint John's, and these same names are more or less familiar all along the coast wherever the northern coasters and fishing vessels are known.

The name preferable for adoption.

19. The adoption of some one suitable name for popular use is eminently desirable. "Menhaden" is the name most generally known, as well as the most distinctive. It has the additional recommendation of having been derived from an aboriginal language. It has been used in the titles of the two manufacturers' associations, and it is hoped that this usage will soon be conformed to by all.

Trade-names.

20. Among the manufacturers in Port Monmouth, N. J., who prepare the menhaden as an article of food, a number of trade-names are in use, such as "American sardine" (in distinction from the European fish, which is prepared in a similar manner), "shadine," and "ocean trout."*

Etymologies.

21. A few words concerning the origin of the above-mentioned names may not be out of place. "Pogy" and "menhaden" are derived somewhat remotely from the Indian dialects of New England, the latter apparently from that in use in Massachusetts and Rhode Island, the former from a more northern source. The writer is indebted to Prof. J. Hammond Trumbull, of Hartford, Conn., for the following very suggestive letter:

* This fanciful name has been the occasion of many erroneous statements. In the New York Times for April 12, 1874, appeared an article entitled "American Sardines," which contained the following bit of biography: "The fish selected as the substitute for the sardine of Europe is the menhaden, more commonly known as the moss-bunker, and the scientific name of which is *Trutta Occana*, or ocean-trout. Its color is silver, spotted with dark brown, and in the night-time assumes a reddish or fiery tinge. They abound in the seas east of the Canadas and in the bays and deep rivers which indent the New Brunswick, Newfoundland, and Nova Scotia coasts, and from which they migrate in the spring of the year to the southward, and appear in great shoals along the coast of Long Island and in the Raritan and Lower New York bays. A mile or two to the northward of Sandy Hook is their favorite feeding-ground for the spring and summer, and thither they rendezvous toward the close of April in vast schools, numbering millions. They invariably come on with the warm weather, and remain until fall. Their breeding time is late in the winter," &c. These ridiculous statements, evidently compiled in part from printed accounts of the sea-trout (*Salmo immaculatus*, Storer) of the North, partly from the statements of the menhaden fishermen, but principally from the imagination of the writer, would perhaps not be worthy of notice had they not been copied by the European newspapers. A translation, with emendations which make it still more absurd, appeared in *Das Ausland* for August 17, 1874. The Stuttgart paper emends its name to *Trutta trutta*, and states that it resembles in color the brook-trout to which it is very closely allied.

"HARTFORD, CONN., Dec. 19, 1874.

"MR. G. BROWN GOODE:

"MY DEAR SIR: In reply to yours of the 14th respecting the local names of the *Brevoortia menhaden*, about all I can give you is in my note to the new edition of Roger Williams' Key, ch. xix. Williams names, together, among spring fish, "*Aumsuog* and *Munnawhatteaüg*." Under the former name are included several species of the herring tribe, *aum'su* (plural, *aums'uog*) meaning 'small fish.' *Munnawhatteaüg*, corrupted to *Menhaden*, means, literally 'fertilizer' ('that which manures.') This name was applied to the herring and alewife as well as the 'menhaden' proper,—all these species being used by the Indians for manuring their cornfields.

"In the northern and eastern parts of New England the *Brevoortia* is commonly called *Pauhagen*, and probably in some localities 'poghaden' (as you write it and which is nearer the Indian original) though I have not heard it so pronounced by eastern fishermen. This name in the eastern dialects has precisely the same meaning as 'menhaden' (or rather *munnawhatteaüg* in Southern New England). The Abnaki (*i. e.*, coast of Maine) name was *Pookagan* as Rasles wrote it, and the verb from which it is derived he translated by 'on engraisse la terre.'

"*Mossbunker* is classic. Dr. Bartlett in his Dictionary of Americanisms quotes from Dow, jr.'s Sermons a remark that 'under the surface [of some smooth faced people] there may be found as many asperities as there are bones in a *mossbunker*.'

"Jacob Steendam mentions it in his poem 'in the Praise of New Netherland,' printed in 1661. Dankers and Sluyter, the Journal of whose Voyage to New York, 1679, was translated by Mr. Murphy for the L. I. Historical Society's Collection, vol. i. (p. 100), saw in the bay schools of innumerable fish, and a sort like herring called there '*Marsbanckers*.'

"I have never looked for the origin of this name, but have had the impression that it was Dutch, perhaps transferred from some European species. I can make nothing of it as Indian.

"Yours truly,

"J. HAMMOND TRUMBULL."

22. According to Mr. J. V. C. Smith,* the older fishermen of Northern Massachusetts, New Hampshire, and Maine called the fish by the Indian name "Pauhagen," and I myself have heard it called "poghaden" by old fishermen about Cape Cod. The modern name may easily have been derived from this by dropping the final syllable. At the present day this name is almost universally in use among the fishermen north of Cape Cod, though it is occasionally varied by "poggie" and "porgy." The use of the latter name should be carefully avoided: the same name, a corruption of the Indian "scuppaug," being commonly applied to

* Natural History of the Fishes of Massachusetts, embracing a practical essay on angling. By Jerome V. C. Smith, M. D., Boston. Allen and Ticknor, 1833.

another fish, the "scuppaug" or "scup" (*Stenotomus argyrops*.)^{*} As may be supposed, the name of Narragansett origin is most exclusively used in Southern Massachusetts and on the shores of Narragansett Bay, the former home of that tribe of Indians. In its present form it first appeared in print in 1792, in the New York Agricultural Transactions, in an article by the Hon. Ezra L'Hommedieu.[†]

23. "Hard-head" and "bony-fish" explain themselves, both referring to the same peculiarity of structure. The former name was first used about 1813 by Belknap in his History of New Hampshire; the latter, as well as "white-fish," by President Dwight in his Travels in New England.

24. The application of "white-fish" is also sufficiently evident, although this name is not a distinctive one, being applied to a large group of North American fresh-water fishes, the *Coregonidae*, and in certain localities to the bluefish (*Pomatomus saltatrix*). In England the term "white-fish" is used to designate cod, haddock, hake, ling, pollock, soles, turbot, plaice, halibut, and whiting

25. "Mossbunker" is a relic of the days of the Dutch colony at New Amsterdam, and the name is still lovingly retained by the inhabitants of Manhattan Island. It was in use as early as 1661, as we learn from an allusion in Jacob Steendam's poem in "Praise of New Netherland" (*'t Louf van Nieuw Nederland*).[‡]

The allusion to the Mossbunker is as follows :

"Swart-vis, en Roch, en Haring, en Makreel
Schelvis, Masbank, en Voren die (se veel)
Tot walgins toe, de netten'vuld: en heel
Min ward ge-eeten."

"The black and rock-fish, herring, mackerel,
The haddock, mossbanker, and roach, which fill
The nets to loathing; and so many, all
Cannot be eaten."

Allusion has already been made in the letter of Professor Trumbull, to the great schools of "marsbankers" seen by Dankers and Sluyter on their visit to New York, in 1679, and every one remembers the reference to this fish in Irving's "Knickerbocker," in connection with the death of the renowned trumpeter, Antony Van Corlear, where the name first appears crystallized in its present form.[§]

^{*} This probably misled De Kay, who stated that the menhaden were known at the eastern end of Long Island as "skippaugs." He also remarked that "pauhagen" (pronounced *Pauhaugen*) was the Narragansett epithet, while "*menhaden*" was that applied by the Manhattan Indians.

[†] Appendix O.

[‡] This poem, cited by Professor Trumbull in the Report of the Commission of Fish and Fisheries for 1871-'72, p. 168, was printed, with an English translation, by Hon. Henry C. Murphy, for the Bradford Club, of New York (Anthology of New Netherland: Bradford Club Series, No. 4, 1865, pp. 52, 55).

[§] A History of New York * * * By Diedrich Knickerbocker. New York, 1809.

"It was a dark and stormy night when the good Antony arrived at the creek (sagely denominated *Haerlem river*) which separates the island of Mannahatta from the main

The derivation of this name may be easily traced, it having evidently been transferred by the Dutch colonists from the sead or horse-mackerel, *Caranx trachurus* (Linn.) Lacepede, a fish which annually visits the shores of Northern Europe in immense schools, swimming at the surface in much the same manner as our *Brevoortia*, and which is known to the Hollanders as the *Marsbanker*.*

In the Museum Ichthyologicum of Gronow,† published in 1754, the name *Marsbanker* is used in speaking of a scombroid fish, frequently taken with the herring, probably the same below referred to.‡

The name is variously spelled "mossbunker," "mossbonker," "mass-banker," "mousebunker," "marshbunker," "marshbanker," and "morse-bonker," and is also familiarly shortened into "bunker," a name in common use at the eastern end of Long Island.

26. The name "alewife" was given by the Virginia colonists to this species from its resemblance to the allied species known by that name in England. This name is preoccupied by the *Pomolobus pseudoharengus*, and should never be applied to *Brevoortia*.

27. The presence of a parasitic crustacean (*Cymothoa prægustator*) in the mouth of *Brevoortia*, when found in southern waters, explains the name "bug-fish" prevalent in Delaware and Cheaspeake Bays, the Potomac and Rappahannock Rivers, and the inlets of North Carolina, with its local variations of "bug-head" and "buggy-head."§ "Yellow-

land. The wind was high, the elements in an uproar, and no Charon could be found to ferry the adventurous sounder of brass across the water. For a short time he vaped like an impatient ghost upon the brink and then, bethinking himself of the urgency of his errand, took a hearty embrace of his stone bottle, swore most valorously that he would swim across in spite of the devil (Spyt den Duyvel), and daringly plunged into the chasm. * * * An old Dutch burgher, famed for his veracity, and who had been a witness of the fact, related to them * * * that he saw the duyvel, in the shape of a huge moss-bonker, seize the sturdy Antony by the leg and drag him beneath the waves. * * * Nobody ever attempts to swim across the creek after dark, and as to the moss-bonkers, they are held in such abhorrence that no good Dutchman will admit them to his table who loves good fish and hates the devil."

* See Schlegel, Die Dieren van Nederland, Visschen, p. 4.

† Museum | Ichthyologicum, | sistens | Piscium | indigenorum & quorundam exotico-
rum, | qui in | Museo | Laurentii Theodori | Gronovii, J. U. D. | adservantur, descrip-
tiones | ordine systematico. | Accedunt | nonnullorum exoticorum Piscium icones æri
incisæ. | * * * * (Cut) | Lugduni Batavorum, | Apud Theodorum Haak, |
MDCCLIV. | folio, 10 preliminary pages, pp. 70.

‡ 80. *Scomber* linea laterali aculeata, pinna ani ossiculorum triginta, *Arted. Gen.* 25, n. 3, *Synon.* p. 50, n. 3.

Scomber linea laterali curva, tabellis os-
seis loricata, *Gronov. act. ups.* 1742, p. 83,
ibique defer. *Trachurus*, *Bossuet*, epigr. p.
74, *Bellon. Aquat.* p. 180, *Dale. Hist. of*
Harw., p. 131, n. 5.

Belgis *Marsbanker* Frequentissime in
Mari Septentrionale cum Clupeis p. 5, n. 4,
descriptis capitur.

Op. cit. p. 34.

§ Captain Atwood states in the Proceedings of the Boston Society of Natural History, x, 1865, p. 67, that the half-grown menhaden are called "bug-fish" by the Virginia negroes, because they believe them to have been produced from insects, since they never find spawn in them there.

tail," "yellow-tailed shad," and "green-tail" refer to the yellowish-green tint of the caudal fin, observed only in Southern specimens. The former of these names has led to some confusion among our correspondents, the same name being applied in Georgia and Florida to a very different fish, *Bairdiella punctata* (Linn.) Gill.

28. An allusion to the oily nature of the flesh is found in "fat-back," a name in general use in the Southern States. This name is sometimes applied in Northampton County, Virginia, to the mullet (*Mugil lineatus*). In the last century it was used for the *Albula conorhynchus*.*

The conflict of names among the American representatives of the herring family.

29. The representatives of the herring family most abundant in the waters of Great Britain are three—the shad (*Alosa finta*), the alewife (*Alosa vulgaris*), and the herring (*Clupea harengus*). Their names were at an early date appropriated for representatives of the same family on our own coast. The name "shad" is, from Maine to Florida, yielded by common consent to our *Alosa sapidissima*, which, in many particulars, resembles its namesake, though they "be bigger than the English Shaddes and fatter," as an early writer declares.†

In the Southern States this fish is sometimes called "white-shad," to distinguish it from the *Dorosoma Cepedianum*, there known as the "mud-shad" or "gizzard-shad." On the coast of New England, the mattowocca or tailor-herring (*Pomolobus mediocris*) is sometimes called the "hickory-shad," and also the "sea-shad," under which name it is often confounded with the true shad, which is known from recent investigations to be frequently taken far out at sea in company with mackerel, alewives, and menhaden. In the Bermudas, there being no large clupeoid fish, the same name has been for centuries applied to two species which somewhat resemble it externally—*Eucinostomus gula* and *Eucinostomus Lefroyi*, Goode.

The "herring," or "English herring," of New England north of Cape Cod is identical with that of Great Britain, but at certain points in Southern New England, such as New Bedford, this name is transferred to *Pomolobus pseudoharengus*, and on the Hudson River the usage is general, though the species is occasionally called the alewife. South of the Hudson the name "herring" is universally used in connection with this species of *Pomolobus*, and the allied *Pomolobus mediocris* or "mattowocca," which is known as the "tailor-herring" or sometimes, as in the Saint John's River and about Cape Cod, as the "hickory-shad." In the great lakes the name "herring" is also represented, being applied to one of the whitefish family, the lake-herring (*Argyrosomus clupeiformis*).

To *Pomolobus pseudoharengus* the name "alewife" is commonly ap-

* See Garden, in Correspondence of Linnæus, p. 335.

† New England's Prospect. By William Wood. London, 1634.

applied in New England, and even, occasionally, as mentioned above, in New York. South of New York it is used for *Brevoortia tyrannus* only. The name is corrupted into "old-wife" and "ell-wife," "wife," and on the Connecticut River appears under the guise of "ell-whop." At Maurice River the *Brevoortia* is called "old-wife chebog," "chebog" being probably of Indian origin. Thomas Morton, writing in 1632 of the fishes of Virginia, gives the names "shadd" and "allize" as in use among the colonists at that time.* The original derivation of the word "alewife" is somewhat obscure, though it may probably have originated in *Alausa*, the name applied by Ausonius to the European shads in his celebrated poem on the Moselle River—

Quis non ——— norit,
Stridentisque focis opsonia plebis alausas.

The transition through the French "alose," the English "allis," "allice," or "alize," is not difficult, and when we find these names together with "alewife" applied indiscriminately to the same fish, it is, to say the least, suggestive. Such an etymology is at least more satisfactory than that of Josselyn, so often quoted: "The Alewife is like a Herrin, but has a bigger bellie; therefore called an Alewife."†

6. ZOOLOGICAL NAMES.

Latrobe's description of Clupea tyrannus.

30. Our species was first described by Mr. B. H. Latrobe, in a communication to the American Philosophical Society in 1802,‡ under the name *Clupea tyrannus*. Although this article, and the name therein proposed, have long since been lost sight of, there can be little doubt that they refer to the menhaden, and that the laws of priority demand that the species shall henceforth be known as *Brevoortia tyrannus*. The fishes of the Chesapeake and its tributaries have, until within the past three years, been very little studied, and the habits of the menhaden in those waters are so different that it is not strange for Northern ichthyologists to have made mistaken identifications of Latrobe's specific name.§ In fact, it was supposed, not many years since, that the southern limit of the menhaden was north of the Capes of Delaware, while its habit of ascend-

* New English Canaan; or New Canaan; containing an abstract of New England. Force's Hist. Tracts, vol. ii, Tract 5.

† An Account of two voyages to New England, a Description of the country, natives, and creatures. By John Josselyn, Gent. 1675. Col. Mas. Hist. Soc., 3d series, III. 1833.

‡ A Drawing and Description of the *Clupea Tyrannus* and *Oniscus prægustator*. By Benjamin Henry Latrobe, F. A. P. S. < Transactions of the American Philosophical Society held at Philadelphia for promoting useful knowledge. Vol. V, 1802, p. 77.

§ Dr. Dekay, misled by the name "alewife," which he supposed to be applied to the same species at the north as in southern waters, applied Latrobe's name to the northern "alewife," calling it *Alosa tyrannus*, a usage which was concurred in by Storer and by Cuvier and Valenciennes. The same name was referred to the shad by Professor Gill in some of his earlier writings.

ing the rivers of the South and the presence of the peculiar parasite were quite unknown.

Latrobe's description is reproduced in Appendix D, and the reader may decide the question for himself. It is believed that the following circumstances clearly indicate the meaning of its author :

(1.) The figure, while undeniably bad, resembles the menhaden very closely, and manifestly cannot be intended to represent any allied species. The contour, were the missing dorsal fin supplied, is similar to that of the menhaden, the black spot upon the scapular region is constant in the menhaden only, though a similar one is occasionally seen upon the shad and the alewife. While the figure resembles somewhat the menhaden, it does not resemble the allied species.

(2.) The name "bay alewife" is still applied to the menhaden in this region. This is a strong argument, for, although seventy-five years have passed since Latrobe wrote, the persistence of popular names is very remarkable, as I have elsewhere pointed out.* Moreover, Latrobe was also acquainted with a "herring" and a "shad." These being eliminated, there is no fish but the menhaden to which the description in question can refer.

(3.) The habits of the alewife as described by Latrobe are essentially the same as those of the menhaden in the present day. As has been remarked, it is only recently that the river-ascending habits of the species have been understood, and the statement that the alewife began to ascend the Potomac in March, which was two months earlier than the menhaden was known to strike our coast, formerly was thought to throw the identity of the two out of question.

(4.) The presence of the crustacean parasite is the strongest argument of all. While this is found in the mouths of a large percentage of the southern menhaden, it has never once been found attached to any other species, although careful search has been made by several persons. As has been remarked, the northern menhaden are free from this parasite, and this is still another reason for the failure to identify.

31. The next mention of this species was by Professor Mitchill, under the name *Clupea menhaden*.† By this specific name it has been known ever since, and it is to be regretted that it is necessary to replace by another a name so appropriate and of such long standing.

Descriptions of later dates.

32. In 1818, the eccentric Rafinesque redescribed the species as *Clupea neglecta*, the specific name being chosen because he supposed the species to have been neglected by Dr. Mitchill in his comprehensive catalogue of the fishes of New York.‡

* Catalogue of the Fishes of the Bermudas, 1876, p. 15.

† The fishes of New York described and arranged. < Transactions of the Literary and Philosophical Society of New York, Vol. I, 1815, p. 453.

‡ American Monthly Magazine, Vol. II, 1818, p. 206.

33. In Belknap's History of New Hampshire, this species is mentioned under the name "*Clupea dura laevi mystax* (hardhead)."^{*} Since no description is given, this name can have no significance.

34. Mitchell's "New York Shadine" (*Clupea sadina*)[†] appears to be identical with *Brevoortia tyrannus*, as is indicated by the smutty opercular spot, the wide and toothless mouth, and protruding gill apparatus. The deciduous character of the scales may have been due to poor preservation of the type specimen.

Gronow, in 1763, described the species under the name *Clupea Carolinensis*,[‡] but his manuscript was not published until 1854, and his name must yield precedence to those which are really much more recent.

The Gulf Menhaden.

35. A second North American species of menhaden has recently been discovered. A description will be given in a subsequent paragraph (42). This species has been reported only from the Gulf of Mexico. The name chosen for it has reference to the presence of a parasite which has already been mentioned, and which was described by Latrobe as the *Oniscus prægustator*. This parasite is common to both *Brevoortia tyrannus* and *Brevoortia patronus*, the gulf form; the specific name of the latter has been selected to carry out the quaint conceit of Latrobe, who fancied that the menhaden resembled a Roman ruler in having a "taster" who first tested every dish to prove its harmlessness.

The Menhaden of Brazil.

36. The species described, from Brazil, by Agassiz and Spix, under the name *Clupanodon aureus*[§] does not appear to be distinctly separated from *Brevoortia tyrannus*. No diagnostic characters can be detected in the descriptions of either Agassiz or Günther; that is to say, characters which do not disappear upon the study of a large series of specimens. Agassiz's specimens, collected probably at Bahia, and in 1829 preserved in alcohol in the Munich Museum, were eight inches long. He himself seems to have had an inkling of their identity with the North American species, from the fact that he cites, doubtfully, as a synonym, Mitchell's *Clupea menada*. The difference in spelling this specific name is doubtless an attempt to put in Latin form the Indian name used by Mitchell. Two specimens from Sambaia, Brazil, and one from Rio Janeiro, collected by the Thayer expedition, agree closely with the figure in Spix's.

^{*} Belknap's History of New Hampshire, 2d ed., 1813, III, p. 133.

[†] Trans. Lit. and Phil. Soc., N. Y., 1814, pp. 457, 458.

[‡] Catalogue of Fish, collected and described by Lawrence Theodore Gronow, now in the British Museum. Published by order of the Trustees, London, 1854, pp. 140.

[§] Selecta | Genera et Species | Piscum | quos | in Itinere per Brasiliam | Annis MDCCCXVII-MDCCCXX | * * * | collegit, et pingendos curavit | Dr. J. B. de Spix, | * * * | digessit, descripsit, et observationis anatomicis illustravit | Dr. L. Agassiz, | * * * | Monachii, | Typis C. Wolf | = | 1829, p. 52.

work. The species is not well separated, and is at best but a geographical race of *Brevoortia tyrannus*.

Darwin's Menhaden.

37. The *Alosa pectinata* described by Jenyns,* from specimens collected by Charles Darwin at Bahia Blanca, appears to be a well-defined species, distinguished chiefly by the lesser number of transverse rows of scales. In the Natural Museum is a specimen (No. 1709) collected by Captain Page, U. S. N., in the expedition of the United States steamer "Waterwitch" to Paraguay. The extremely pectinate scale, given in the figure of *Alosa pectinata*, and upon which so much stress is laid by Mr. Jenyns, is taken from one of the differentiated rows immediately in front of the dorsal fin, which are alike pectinate in all species of the genus. Two specimens belonging to the Museum of Comparative Zoology, collected in the Rio Grande, agree thoroughly with Mr. Jenyns' description and with the Paraguay specimens already referred to.

Generic relations.

38. Dr. Storer first referred the species to the genus *Alosa*, where it stood until 1861, when Professor Gill proposed for it a new genus, which he named *Brevoortia*, in honor of the Hon. J. Carson Brevoort, of New York City. This genus is characterized by peculiarities of structure in scales, gills, gill-rakers, and alimentary canal.

A revision of the American species.

39. The type of the genus *Brevoortia* of Gill is the species described in 1802 by Latrobe under the name *Clupea tyrannus*, and later by Mitchill under the name *Clupea menhaden*. As has already been indicated (Proceedings U. S. National Museum, vol. 1, p. 5), the former name has the prior claim to adoption, and the species must be called *Brevoortia tyrannus*. Of this species there appear to be two geographical races or subspecies. One of these is the typical form of the Atlantic coast of the United States, the other a closely-allied form from the coast of Brazil, already described by Spix under the name of *Clupanodon aureus*. For the species the name of Latrobe should be retained, and the two subspecies may be distinguished as *Brevoortia tyrannus*, *menhaden* and *Brevoortia tyrannus, aurca*: a third subspecies is temporarily adopted to include some aberrant forms from Noank, Conn., for which the name *Brevoortia tyrannus brevicaudata* is proposed. On the coast of Patagonia and Paraguay occurs a well-marked species, described by Jenyns under the name of *Alosa pectinata*. This species is readily distinguished by its larger scales, which are arranged in 18 to 20 lateral rows, instead of 25 to 27, as in *B. tyrannus*. The generic relations of this species were recognized many years ago by Professor Gill, and its name should stand as *Brevoortia pectinata*, (Jenyns) Gill.

*The Zoology of the Voyage of H. M. S. Beagle, &c. * * * Part IV. Fish.
* * * London, 1842., p. 135, pl. xxv.

A third species occurs in the Gulf of Mexico. It is distinguished by its larger head and fins and other characters. It appears to have never been described, and, for this form, the name of *Brevoortia patronus* is proposed. It is accompanied by the same crustacean parasite that is found in the mouths of *B. tyrannus*, to which Latrobe gave the significant specific name of *prægustator*.

C.—DESCRIPTIONS OF THE AMERICAN SPECIES OF MENHADEN, WITH ANATOMICAL AND PHYSIOLOGICAL NOTES.

7.—TECHNICAL DESCRIPTIONS.

Brevoortia tyrannus.

40. The following is a careful description of the common menhaden, which occurs on the east coast of the United States and Brazil :

Brevoortia tyrannus (Latrobe) Goode. THE MENHADEN.

Diagnosis.—Head and jaws short; the length of the head less than one-third of the length of the body less the caudal fin; especially short in subsp. *aurea*, the maxillary in length much less than three-twentieths of the length of the body.

Height of body about one-third of total length, in very fat individuals about three-eighths. Fins comparatively short, the height of the dorsal less than length of maxillary, and considerably less than three-tenths of length of body; that of the anal usually less than half that of maxillary; that of ventral always less than one-tenth of total length; the length of middle caudal rays one-fifth that of body, and less than that of exterior caudal rays, usually about three-fourths, often less than two-thirds, and rarely more than five sixths of total length. Fins all shorter in subsp. *aurea*. Insertion of ventral far behind tip of pectoral. Insertion of dorsal about equidistant from snout and base of middle caudal rays, but varying two or three one-hundredths to either side of this median point, and always slightly behind the vertical from insertion of ventral.

Scales of medium size, much serrated, arranged very irregularly in 24–26 transverse and 60–80 longitudinal rows. Scales forming sheath at base of pectoral not large. Squamation of caudal lobes moderate. Operculum strongly striated in subsp. *menhaden*, almost smooth in subsp. *aurea*. Scapular blotch conspicuous.

This species is easily distinguished from *Brevoortia patronus* by its shorter head and fins, by its slender body and its pectinated scales, and from *B. pectinata* by its smaller, less regularly arranged, and more numerous scales, and its shorter, less furcate caudal fin.

Individual variations and special descriptions.

Head.—The length of the head varies from 28 to 33 hundredths of total length. The posterior end of the maxillary extends to a point in the vertical from the centre of the orbit. The length of the skull, as

indicated by the "distance from snout to nape," varies from .19 to .23. The length of snout, measured from a line drawn perpendicularly through the centre of the orbit, varies from .09 to .11. The length of maxillary varies from .12 to .14½; that of mandible from .15 to .18. The diameter of the eye enters 4½ times in the length of the head; its width varies from .11 to .15 in very fat individuals.

Shape of body.—This is exceedingly variable, and the variation is caused largely by the fatness of the individual. In very plump ones, the expansion of the belly throws back the origin of the ventrals and anal, and greatly changes the appearance of the fish. In the specimens before me the height of the body ranges from .31 to .38½. The table of measurements subjoined shows the effect of increased height of body upon the other measurements of proportion.

Fins.—The range of variation in the position of the dorsal is indicated in the diagnosis. There is no appreciable correlation between the positions of the dorsal and anal in the same specimen. The insertion of the anal is distant from the snout from .68 to .75. The length of the rays in dorsal, anal, ventral, and caudal vary much, as the table of measurements indicates. In the caudal the upper lobes vary from .16 to .25, the lower lobes from .18 to .27. The relation of the pectoral and ventral fins is much affected by the length of the head, the insertion of the former being thrown much farther back in long-headed individuals.

Scales.—The degree of serration varies much in individuals as well as the squamation of the bases of the vertical fins, and the number and regularity of the body-scales. In young individuals the scales are arranged with much regularity, but in the adults I have strong reason to believe that other scales are intercalated here and there throwing the arrangement into great disorder and rendering an accurate enumeration impossible.

Subspecies.

The series before me embraces some two hundred specimens of *Brevoortia tyrannus* of various ages, seasons, and localities. Almost every feature is subject to wide variations, and there is usually no decided correlation between different characters except that a long head is accompanied by long jaws and a pectoral set farther back and extending more nearly to the insertion of the ventral. There are, however, certain groups of individuals which can be included within a diagnosis, which may serve to distinguish them from all the others of the same species. To what extent it is desirable to define varieties which are not separated geographically, I am not well satisfied. The exact meaning of the terms "sub-species" and "variety," as employed by Cope, Coues, Gill, Yarrow, and other recent writers, has not been definitely interpreted. It seems desirable, however, to designate in some way the limits of variation from the normal specific types in different directions. With this purpose, and remarking that by a subspecies I mean simply a divergent form connected by intermediate forms with the typical specific form, I have

thought it desirable to name provisionally two varieties, and to call attention to others which may possibly exist. This is done with much hesitation, and only with a view to an attempt to formulate the minor differences to be observed between fish of the same species on different parts of our coast. A precisely parallel case is to be found in the shad of the different Atlantic rivers, which are well-known to exhibit strong distinctive marks. Very possibly every school of menhaden has its own characteristics. In every case where I have had an opportunity to observe them, the individuals composing the same school were closely similar to each other.

The typical form of the species, as now defined, is taken from the coast of Southern New England and the Middle States. It has the height of the body about one-third of the total length, the head three-tenths of the total length, or a little more; the maxillary long (.14 to .14½), and exceeding the height of the dorsal.

The species described by Spix, under the name of *Clupanodon aureus*, cannot be distinguished by any apparent specific characters from *Brevoortia tyrannus*, since one or more of the specimens of the latter species before me partakes of some of the peculiarities of the Brazilian form. There is, however, a general average of character exhibited by the Brazilian specimens, as well as the figure of Spix, with which they closely agree, which seems to me to entitle them, for the present at least, to recognition as belonging to a distinct geographical race. The distinctive characters appear to consist in (1) a greater average height of body; (2) a lesser length of head; (3) a lesser average length of maxillary and mandible; (4) a slightly lower anal and dorsal fin; (5) a greater average distance of anal from snout; (6) a greater average length of the medial caudal rays; (7) a shorter average length of pectoral; (8) a more regular arrangement of the scales, and a more luxuriant growth of small scales at the basis of the fins.

A number of specimens from Noank, taken in 1874, vary quite as much from the normal type, and in almost the same respect as the variety just described. The maxillary and mandible are shorter, however, than in the Brazilian form, the anal fin lower and the lobes of the caudal are extremely short, sometimes hardly exceeding in length the pectoral fin. But for the fact that these specimens show almost all the characters of the Brazilian *Brevoortia*, and in some cases exaggerations of them, I should be inclined to consider the *aurea* a distinct species. Having with some hesitation allowed to this the rank of a subspecies, the question must be decided as to the propriety of also allowing subspecific rank to this peculiar form from Noank. The exact meaning of the terms subspecies and variety, as recently employed by zoologists, is not very clear to my mind, but I infer a "subspecies" to be composed of an assemblage of individuals varying uniformly from the typical specific forms in a degree sufficient to be susceptible of description and definition, though not necessarily separated from it by the absence of

connecting forms. Premising, then, that in giving to the Noank specimens a subspecific name, my object is simply to define the limits of variation from the normal type in a given direction, I would provisionally propose that they be designated as subspecies *brevicaudata*.

The specimens from the Saint John's River, Florida, are extremely variable in every respect. Certain individuals show a tendency to elongation of the head and fins, and also a slenderness of the posterior part of the body, and nearly all the individuals from that region are more lightly and gracefully shaped; they all have a tendency to a yellow coloration, especially upon the caudal lobes. I have not felt justified, however, in calling it a subspecies.

I have not had an opportunity to study the Maine schools, but am inclined to believe that their differences are very perceptible.

In plate VI are shown the chief variations of form. Fig. 1 shows the typical form; fig. 2 the subspecies *brevicaudata*; fig. 3 the average form from the Saint John's River, Florida; fig. 4 the subspecies *aurea*.

Table of measurements.

Current number of specimen.....	10,405 = 709 C. A. S.		10,405 = orig. No. 247.		20,666 a.	
	Wood's Holl.		Wood's Holl.		Wood's Holl.	
	Millim.	100ths.	Millim.	100ths.	Millim.	100ths.
	<i>Very fat.</i>		<i>Plump.</i>			
Extreme length	251		243		130	
Body:						
Greatest height		38½		31½		34½
Least height of tail		9				9
Length of caudal peduncle		9½				
Head:						
Greatest length		32		31		31
Distance from snout to nape		20		20½		20½
Greatest width		15				
Length of snout from perp. from centre of orbit		10		10		10½
Length of operculum		9		9		9
Length of maxillary		14½		14½		14
Length of mandible		17½		17½		17
Distance from snout to center of orbit		10½		10½		10½
Dorsal:						
Distance from snout		54		51		49
Length of base		19		17½		17½
Origin of pectoral to origin of dorsal		41		33½		35½
End of dorsal to end of anal		25½		24		25
Length of longest ray		12½		11		12½
Length of last ray		6		7		6½
Anal:						
Distance from snout		73		72		72
Length of base		14		14½		15½
Origin of anal to origin of dorsal		39		33		36
Length of longest ray		6½		5½		6½
Length of last ray		5½		4½		4½
Caudal:						
Length of middle rays		5½		4½		5½
Length of external rays, superior		23		20½		20
inferior		26½		23		23
Pectoral:						
Distance from snout		30		32		30
Distance of tip from snout		48½		48		46
Length		19		17½		18
Length of longest axillary appendage		11				
Ventral:						
Distance from snout		53		53		51
Length		8½		7½		9
Origin of ventral to end of dorsal		38		31		33
Dorsal	18		20		20	
Anal	21		20		21	
Number of scales in lateral line	94		107			

Table of measurements—Continued.

Current number of specimen	20,666 b.		18,049 b.		1,696 a.	
Locality	{ Wood's Holl.		{ Saint John's River.		{ Indian River, Florida.	
	Millim.	100ths.	Millim.	100ths.	Millim.	100ths.
Extreme length.....	132		140		<i>Fat.</i> 106	
Body:						
Greatest height.....		34		34		37
Head:						
Greatest length.....		32		30		30
Distance from snout to nape.....		23		21		20
Greatest width.....		11		11		
Length of snout from perp. from center of orbit.....		11½		10		10
Length of operculum.....		9		9½		9
Length of maxillary.....		14½		13		13½
Length of mandible.....		17½		16		17
Distance from snout to center of orbit.....		12				
Dorsal:						
Distance from snout.....		53		49		50
Length of base.....		19		18		17
Origin of pectoral to origin of dorsal.....		35		34		36
End of dorsal to end of anal.....		24		26		30
Length of longest ray.....		12		12		13
Length of last ray.....		6		6½		5
Anal:						
Distance from snout.....		72		71		72
Length of base.....		15		16		16
Origin of anal to origin of dorsal.....		34		36		38
Length of longest ray.....		6½		8		*5+
Length of last ray.....		5		5		*3+
Caudal:						
Length of middle rays.....		6		6½		*4+
Length of external rays, superior.....		22½		24		*22
inferior.....		27		27		*24
Pectoral:						
Distance from snout.....		32		30		30
Distance of tip from snout.....		48½		47		
Length.....		18		17		
Ventral:						
Distance from snout.....		52		50		50
Length.....		9½		9		
Origin of ventral to end of dorsal.....		33		33		35
Dorsal.....	20		19		18	
Anal.....	21		20		20	

Current number of specimen	5,152		17,937.		19,046.	
Locality	{ West Florida.		{ Saint John's River, Fla.		{ Saint John's River, Fla.	
	Millim.	100ths.	Millim.	100ths.	Millim.	100ths.
Extreme length.....	101		(7-inch.) 178		230	
Body:						
Greatest height.....		38		34½		32
Least height of tail.....				10		9
Length of caudal peduncle.....				8		8
Head:						
Greatest length.....		29		31½		33
Distance from snout to nape.....		20		20½		20½
Greatest width.....		10		12		12
Length of snout from perp. from center of orbit.....		10		10		10½
Length of operculum.....		9½		9½		9½
Length of maxillary.....		13		14		14½
Length of mandible.....		15		18		18
Distance from snout to center of orbit.....				11½		10½
Dorsal:						
Distance from snout.....		48		52		52½
Length of base.....		18		21		17
Origin of pectoral to origin of dorsal.....		36		34½		34
End of dorsal to end of anal.....		30		26		25
Length of longest ray.....				12		12
Length of last ray.....				5		

* Broken.

Table of measurements—Continued.

Current number of specimen	5,152.		17,927.		19,046.	
Locality	{ West Florida.		{ Saint John's River, Fla.		{ Saint John's River, Fla.	
	Millim.	100ths.	Millim.	100ths.	Millim.	100ths.
Anal:			(7-inch.)			
Distance from snout				68		72
Length of base				16		16
Origin of anal to origin of dorsal				38		32½
Length of longest ray				6½		6
Length of last ray				5		6½
Caudal:						
Length of middle rays				5		5½
Length of external rays, superior				21		20
inferior				23		24
Pectoral:						
Distance from snout				31½		32
Distance of tip from snout				49		50
Length				19		18
Length of longest axillary appendage				12		
Ventral:						
Distance from snout				49		48
Length				9		9
Origin of ventral to end of dorsal				33½		30
Dorsal	20		21		18 or 19	
Anal	21		21		21	
Current number of specimen	19,044.		18,049 α.		19,468.	
Locality	{ Saint John's River, Fla.		{ Saint John's River, Fla.		{ Virginia.	
	Millim.	100ths.	Millim.	100ths.	Millim.	100ths.
Extreme length	192		144		234	
Body:						
Greatest height		34		34		32
Least height of tail						9
Length of caudal peduncle						9
Head:						
Greatest length		29		29		32½
Distance from snout to nape		19		19		20½
Greatest width		12		11		12
Width of interorbital area						7
Length of snout from perp. from center of orbit		9½		10		10
Length of operculum		10		10		9
Length of maxillary		13		13		14
Length of mandible		16		16½		18
Distance from snout to center of orbit		10		11		11
Dorsal:						
Distance from snout		49		49		51
Length of base		17		17		18½
Origin of pectoral to origin of dorsal		35		35		34
End of dorsal to end of anal		27		29		23
Length of longest ray		12		12½		11
Length of last ray		6		6½		5½
Anal:						
Distance from snout		71		71		72
Length of base		17		17½		14½
Origin of anal to origin of dorsal		34		37		33
Length of longest ray		6		7		5½
Length of last ray		6		4		6
Caudal:						
Length of middle rays		6		5		4
Length of external rays, superior				25		
inferior		23		27		24
Pectoral:						
Distance from snout		30		30		32
Distance of tip from snout		45		45		49
Length		16		17		18
Length of longest axillary appendage						12
Ventral:						
Distance from snout		49		50		51
Length		9		8½		9
Origin of ventral to end of dorsal		34		34		30
Dorsal	19		18		19	
Anal	23		21		21	

Table of measurements—Continued.

Current number of specimen {	14,846 a.		14,846 b.		Brevoortia aurea. M. C. Z.	
	Noank.		Noank.		Rio Janeiro.	
Locality	Millim.	100ths.	Millim.	100ths.	Millim.	100ths.
Extreme length	157		156		236	
Body:						
Greatest height		34		34½		35
Head:						
Greatest length		29		28		27½
Distance from snout to nape		20				21
Length of snout from perp. from center of orbit		10		9		10
Length of operculum		9½				
Length of maxillary		13		12		12
Length of mandible		14½		14		15
Distance from snout to center of orbit		10				
Dorsal:						
Distance from snout		49		47		51
Length of base		19		20		
Origin of pectoral to origin of dorsal		35		34		
End of dorsal to end of anal		25		25		
Length of longest ray		10		9		10
Length of last ray		6		6		4
Anal:						
Distance from snout		74		72½		73
Length of base		15		16		
Origin of anal to origin of dorsal		36½		37		
Length of longest ray		4½		5		5
Length of last ray		4		4½		4
Caudal:						
Length of middle rays		4½		5½		5
Length of external rays, superior		17		16		23
inferior		18		20½		
Pectoral:						
Distance from snout		28		28		28
Distance of tip from snout		41		43		42
Length		12		15		15
Ventral:						
Distance from snout		52		50		49
Length		7		7		8
Origin of ventral to end of dorsal		34		36		
Dorsal	20		20		II 17	
Anal	19		20		19	

Current number of specimen	B. aurea, A.		B. aurea, B.		Average.
	M. C. Z.	Thayer	M. C. Z.	Thayer	
Locality	Sambaia.	Exp.	Sambaia.	Exp.	
	Millim.	100ths.	Millim.	100ths.	100ths.
Extreme length	164		154		
Body:					
Greatest height		37		34	35
Head:					
Greatest length		28		29	28
Distance from snout to nape		19		22	21
Length of snout from perp. from center of orbit		9		10	09½
Length of maxillary		13		14	13
Length of mandible		15		17	15½
Dorsal:					
Distance from snout		49		48	49½
Length of longest ray		12		10	10½
Length of last ray		5		5	04½
Anal:					
Distance from snout		75		73	73½
Length of longest ray		6		5	05½
Length of last ray		4		3	03½
Caudal:					
Length of middle rays		6		5	05½
Length of external rays, superior		25		23	23½
inferior					
Pectoral:					
Distance from snout		29		30	29
Distance of tip from snout		44		47	44½
Length		16		16	15½
Ventral:					
Distance from snout		53		52	51½
Length		7		7	07½
Dorsal	II 17		II 17		
Anal	20		22		

Brevoortia patronus.

41. The following is a careful description of the new species of *Brevoortia* from the Gulf of Mexico:

***Brevoortia patronus*, spec. nov.** Goode. THE GULF MENHADEN.

Diagnosis.—Head larger than in the other American forms; its length usually more than one-third that of the body, the maxillary about three-twentieths of the length of the body.

Height of body always more than three-eighths of its total length, its anterior inferior profile cultrate, convex, giving an obtusely rounded profile to the subpectoral outline, and throwing the snout above the median horizontal axis of the body. Fins long and powerful; the height of the dorsal usually equal to the length of the maxillary and about three-tenths of total length of body; that of the anal equal to a greater than half the length of the maxillary; that of the ventral one-tenth of body-length; length of middle caudal rays always more than one-fifth and often more than one-fourth the length of the head; that of the exterior rays almost equal in length to the head and rarely less than five-sixths of its length. Insertion of the ventral under or slightly posterior to the tip of the pectoral. Insertion of dorsal always posterior to a point on the dorsal outline equidistant from the snout and the base of the medial caudal rays (sometimes as much as seven-one-hundredths of total length), and always in advance of the vertical from the insertion of the ventral.

Scales of medium size, with entire fluted margins arranged regularly (in young) in 24–25 transverse and 50–70 longitudinal rows. Scales forming sheath at base of pectoral very large, round squamations of caudal lobes inconspicuous. Axillary appendages large. Operculum smooth or very delicately striated; scapular blotch inconspicuous.

The variations of individuals are sufficiently indicated in the subjoined table of measurements. The most characteristic specimens occur at Brazos Santiago, Tex., and the more northern specimens show a tendency to shortening up of the head, jaws, and fins.

* *Description*.—The body is much compressed, especially below and in advance of the pectorals; the contour of the belly between the ventrals and the gill-opening is cultrate, projecting, obtusely rounded. The height of the body equals two-fifths of its length, and the least height of the body at the tail is one-fourth of its greatest height in front of the pectorals. The length of the caudal peduncle, from the end of the anal to the base of the exterior lobes of the caudal, is one-fifth of the height of the body and one-twelfth (.08) of its length.

The head is elongated and large, triangular; its length is more than one-third (.35 and .34) that of the body, and its height at the nape is slightly more than its length. The length of the skull, as indicated by the distance from snout to nape, is about one-fourth (.24 and .24½) of the

* To avoid confusion this is drawn up from the Brazos Santiago specimens, which are most characteristically developed.

length of the body, and the greatest width of the head (.13) slightly exceeds the half of this. The width of the interorbital is about equal to the diameter of the orbit and slightly more than one-fourth the length of the head. The maxillary reaches to the vertical from the posterior margin of the pupil; the mandible nearly to the vertical from the posterior margin of the orbit. The length of the maxillary is about equal to that of the longest ray of the dorsal fin (.15 to .16); that of the mandible (.19), to half the distance from the origin of the anal to the origin of the dorsal (.38), or to the length of the base of the anal (.18). The distance from the tip of the snout to the center of the orbit (.13 to .13 $\frac{3}{4}$) equal the greatest width of the head. The length of the operculum is equal to that of the eye; the opercular striations are fine, but distinct and numerous. The dorsal fin is inserted posteriorly to a point equidistant from the snout and the base of the caudal, and in advance of the vertical from the insertion of the ventrals. Its length of base (.20 to .21 $\frac{1}{2}$) is double that of the operculum. Its greatest height is nearly half the length of the head. It is composed of 19 rays, of which the third is the largest. Its upper edge is slightly emarginated. The height of the last ray (.10) is equal to half the length of the base. The distance of the anal from the snout is slightly less than three-fourths of the length of the body (.70-.72); its length of base (.18-.18 $\frac{1}{2}$) one-fourth of this distance. The distance from the origin of the pectoral to the origin of the dorsal (.37-.37 $\frac{1}{2}$) is about equal to that from the origin of the anal to that of the dorsal (.38). Its height (.9-.9 $\frac{1}{2}$) is about half its length of base; its least height (at last ray), one-third of the same (.6-.5 $\frac{1}{2}$). The fin is composed of 22 rays, its edge slightly emarginated. The caudal fin is much forked and elongate; the middle caudal rays (.08) half the length of the maxillary; the exterior rays above (.31-.32) twice that length; the lower exterior rays (.35-.34) nearly equal to twice the length of the mandible.

The pectoral fin is strong, falcate, inserted under the angle of the suboperculum at a distance from the snout (.35-.34) about midway to the insertion of the anal. Its tip extends beyond the insertion of the ventrals, its length (.22) being nearly two-thirds that of the head. The axillary appendages are half as long as the fin, or more.

The distance of the ventral from the snout (.54-.55) is about the same as that of the dorsal, though by the contour of the body it is thrown slightly behind the point of dorsal origin. Its length (.10) is equal to that of the last ray of the dorsal. The scales are quite regularly arranged in about 24 to 25 horizontal and 50 vertical rows. Their free portion is narrow and high. They are entire at the edges and fluted or crenulated. There are two rows of differentiated scales upon each side of the dorsal line, but they are scarcely pectinated. The scales forming the sheath at the base of the pectoral are large and round. Color: silvery, with a brassy sheen upon the sides and greenish-gray upon the back.

Table of measurements.

Current number of specimen.....	892 a.		892 b.		891 a.	
Locality	{ Brazos Santiago, Tex.		{ Brazos Santiago Tex.		{ Mouth of Rio Grande.	
	Millim.	100ths.	Millim.	100ths.	Millim.	100ths.
Extreme length.....	106	-----	104	-----	96	-----
Body:						
Greatest height.....		40½		40½		28
Least height of tail.....		11		10		10
Length of caudal peduncle.....		8		8		-----
Head:						
Greatest length.....		25		34		33
Distance from snout to nape.....		24½		24		23½
Greatest width.....		13		13		11
Length of snout from perp. from center of orbit.....		12		11½		12
Length of operculum.....		10		10		11
Length of maxillary.....		16		15½		16
Length of mandible.....		19		18½		19
Distance from snout to center of orbit.....		13½		13		12½
Dorsal:						
Distance from snout.....		53		53½		51
Length of base.....		21½		20		17
Origin of pectoral to origin of dorsal.....		37		37½		37
End of dorsal to end of anal.....		25		26		26
Length of longest ray.....		15		16		14½
Length of last ray.....		10		9		7½
Anal:						
Distance from snout.....		72		70		70½
Length of base.....		18½		18		19
Origin of anal to origin of dorsal.....		38		38		36
Length of longest ray.....		9		9½		7½
Length of last ray.....		6		5½		5
Caudal:						
Length of middle rays.....		8		8		8
Length of external rays, inferior.....		31		32	{ (") (†)	26 28
Pectoral:						
Distance from snout.....		35		34		33½
Distance of tip from snout.....		55		54		53
Length.....		22		22		18½
Length of longest axillary appendage.....		11		13		-----
Ventral:						
Distance from snout.....		53		52		54
Length.....		10		10		10
Origin of ventral to end of dorsal.....		36		35		33
Dorsal.....		19		19		18
Anal.....		22		22		22
Number of scales in lateral line.....	47 to 50	-----	47 to 50	-----	465	-----

Current number of specimen.....	891 b.		891 c.		5,864 a.	
Locality	{ Mouth of Rio Grande.		{ Mouth of Rio Grande.		{ New Orleans Academy.	
	Millim.	100ths.	Millim.	100ths.	Millim.	100ths.
Extreme length.....	90	-----	73	-----	86	-----
Body:						
Greatest height.....		41½		40		38
Least height of tail.....		11		7½		-----
Length of caudal peduncle.....		7½		-----		-----
Head:						
Greatest length.....		33		30		32
Distance from snout to nape.....		23		22½		23
Greatest width.....		11		-----		-----
Length of snout from perp. from center of orbit.....		11		11½		12
Length of operculum.....		12		10		10
Length of maxillary.....		14½		14		14
Length of mandible.....		16		17½		17
Distance from snout to center of orbit.....		13		12		-----
Dorsal:						
Distance from snout.....		52		57		50
Length of base.....		19		17		16
Origin of pectoral to origin of dorsal.....		39		37		36
End of dorsal to end of anal.....		28		27		31
Length of longest ray.....		17		14		14
Length of last ray.....		9		7		8

* Superior.

† Inferior.

‡ About.

Table of measurements—Continued.

Current number of specimen	891 b.		891 c.		5,864 a.	
Locality	{ Mouth of Rio Grande.		{ Mouth of Rio Grande.		{ New Orleans Academy.	
	Millim.	100ths.	Millim.	100ths.	Millim.	100ths.
Anal:						
Distance from snout		69		69		72
Length of base		20		19		19
Origin of anal to origin of dorsal		39		37		37
Length of longest ray		8 $\frac{1}{2}$		7	(*)	7
Length of last ray		4 $\frac{1}{2}$		5	(*)	5
Caudal:						
Length of middle rays		7		9		7
Length of external rays, superior		25+		27		27
inferior		27+		27		30
Pectoral:						
Distance from snout		32		30		33
Distance of tip from snout		52		47		48
Length		20		17		18
Length of longest axillary appendage						
Ventral:						
Distance from snout		51		52		53
Length		9 $\frac{1}{2}$		10		9
Origin of ventral to end of dorsal		35		16		32
Dorsal	18		18		19	
Anal	22		21		22	
Number of scales in lateral line	†65		†65		†70	

Current number of specimens	5,864 b.		5,864 c.	
Locality	{ New Orleans Academy.		{	
	Millim.	100ths.	Millim.	100ths.
Extreme length	81		74	
Body:				
Greatest height		36		38 $\frac{1}{2}$
Head:				
Greatest length		30		33
Distance from snout to rape		21 $\frac{1}{2}$		24
Length of snout from perp. from center of orbit		10		11
Length of operculum		10		10
Length of maxillary		13 $\frac{1}{2}$		14 $\frac{1}{2}$
Length of mandible		16		17 $\frac{1}{2}$
Dorsal:				
Distance from snout		57		52
Length of base		18 $\frac{1}{2}$		19
Origin of pectoral to origin of dorsal		33		36
End of dorsal to end of anal		26		25
Length of longest ray		12		14
Length of last ray		5 $\frac{1}{2}$		7
Anal:				
Distance from snout		70		70 $\frac{1}{2}$
Length of base		17		19
Origin of anal to origin of dorsal		36		37
Length of longest ray		6		9
Length of last ray		4		6
Caudal:				
Length of middle rays		6		9 $\frac{1}{2}$
Length of external rays, inferior		25		
Pectoral:				
Distance from snout		30		32
Distance of tip from snout		47		50
Length		17		19
Ventral:				
Distance from snout		53		52
Length		8		10
Origin of ventral to end of dorsal		32		35
Dorsal	18		19	
Anal	20		21	
Number of scales in lateral line	153		153	

* Imperfect.

† About.

‡ Or more.

Brevoortia pectinata.

42. The following is an exact description of Jenyns species of *Brevoortia* from the Atlantic coast of Paraguay and Patagonia:

Brevoortia pectinata (Jenyns) Gill. DARWIN'S MENHADEN.

Diagnosis.—Proportions of head and jaws as in *B. tyrannus*. Height of body almost three-eighths of total length, and greater proportionally than in *B. tyrannus*. Fins nearly as in *B. tyrannus*, but uniformly averaging slightly more; the height of the dorsal somewhat less than three-twentieths of total length; that of the anal equal to or slightly less than half the length of the maxillary. The caudal fin is somewhat longer and more furcate; the length of the external rays never being less than five-sixths of the length of the head, while that of the medial rays remains proportionally the same as in the species first described. Insertion of ventral somewhat behind tip of pectoral, this fin and this dorsal being uniformly somewhat farther back than in *B. tyrannus*; the insertion of the latter from one to four one-hundredths posterior to a point equidistant from the snout and the base of the median caudal rays, and, as in *B. tyrannus*, behind the vertical from the insertion of the ventrals.

Scales very large, considerably serrated, and arranged regularly in 18–20 transverse and 50 longitudinal rows.

Scales forming sheath at base of pectoral not large. Operculum smooth or with inconspicuous and few striations. Squamation upon lobes of caudal extensive and conspicuous.

Variations.

The variations in the individual specimens studied are not of great importance, and are indicated in the tables of measurements.

Table of measurements.

Current number of specimen	1,709.		A.		B.		Average.
Locality	Paraguay.		M. C. Z. Rio Grande.		M. C. Z. Rio Grande.		
	Millim.	100ths.	Millim.	100ths.	Millim.	100ths.	100ths.
Extreme length	250	.....	224	.....	209	.....	.....
Body:							
Greatest height		33		36½		36	36
Head:							
Greatest length		33		30		30	31
Distance from snout to nape		21		21		21	21
Length of maxillary		14½		13		14	14
Length of mandible		18		16		16½	17
Dorsal:							
Distance from snout		54		53		51	52½
Length of longest ray		12½		12		12	12
Length of last ray		6		6		6	6
Anal:							
Distance from snout		70½		70		72	71
Length of longest ray		7		6		5	6
Length of last ray		6		4		4	4½

uniformity in length and weight is less remarkable, however, than the uniformity to be noticed in the shape and proportions of the members of the same schools. Variations are chiefly observable in the thickness and height of the body and the head and in the length of the fins, especially the pectorals and the caudal. These differences in shape are necessarily correlated with the activity and swiftness of the fish. Hence the differences in the wariness, swiftness, and difficulty in capture, so often referred to by old menhaden fishermen.

As a general rule, according to Mr. Dudley, the fall fish are mixed together without reference to fatness; the latest ones, however, which are supposed to be the main fish on their southern migration, are generally fat.

Annual rate of growth.

45. The shad is supposed to attain its full size in four years. Captain Atwood believes that the mackerel requires an equal length of time in which to grow to its adult size of 17 or 18 inches. From studies made in 1856, he concluded that they grew to the length of 2 inches in about thirty days, and 4 inches in forty-five days, becoming $6\frac{1}{2}$ or 7 inches long before the October migration, the spawning having taken place about the middle of May. In the second year they are the "blinks;" in the third, "tinkers;" and in the fourth, full-grown mackerel. The menhaden must require three and perhaps four years to attain adult size. Those which strike in at midsummer on the coast of New England are probably hatched from the eggs spawned in the previous fall and winter. They are from 2 to 5 inches long. The second year's growth is doubtless represented by the smallest sizes of the schooling fish, measuring from 7 to 10 inches, such as are catalogued in bottles Nos. 14045, 14846, and 18049. The third year's fish would be represented by the abundant schools of fish of 12 and 14 inches, like those with measurements specified in paragraph 43. The full-grown fish are the immense ones taken in Maine and Massachusetts, measuring 16 and 18 inches.

A most interesting circumstance is narrated by Mr. George W. Miles, to whom I am indebted for many very valuable suggestions utilized elsewhere. His observations were made in Long Island Sound. He writes:—"In 1873 there were immense numbers of small fish, from 1 to 2 inches long, which appeared on the surface in the month of September. Thousands of schools could be seen at a time and great numbers in each school. They appeared to take possession of all the waters for the remainder of that season. In 1874 these fish appeared again, late in the season, and were about double the size they were in 1873. In 1875 they appeared again, much earlier, and in 1876 they came in about the first of June, having increased in size and numbers. Apparently they occupied the whole waters of the sound, so much so, that the larger fish which frequented the sound were actually crowded out of it or left for other waters, and remained off Block Island at sea the remainder of the

season, and gave up the field to be occupied by the smaller fish. The result of this abundance of small fish was a complete failure of the fishery for the two years 1875 and 1876. In 1877 we provided ourselves with smaller-meshed nets, and proceeded to catch the smaller fish, which had now attained about two-thirds the average size of fish in this locality and weighed about half a pound each. We could catch these by using nets of 2 $\frac{3}{4}$ -inch mesh. About 15,000,000 of them were taken by our twelve gangs." Mr. Miles's observations seem to indicate that the period of growth sometimes, if not always, extends over a period of five or six years.

Seasonal rate of growth.

46. There is probably a much greater proportional increase in the size of individuals in the three or four months of their sojourn in northern waters than in the winter and spring. This is clearly indicated by the emaciated condition in which they make their first appearance in our waters, their winter's existence having been apparently sustained by the absorption of the fatty tissues elaborated in summer. Indeed, as will be shown below, there is some reason to believe that the winter months are passed in partial or total torpidity.

9.—COLOR AND OTHER MINOR CHARACTERISTICS.

Color of Northern fish.

47. The adult menhaden is a most beautiful fish. Its color is pearly opalescent, like that of the cyprinoid fishes from which the commercial *Essence d'Orient*, or liquid pearl, used by artists, and in the manufacture of paste jewelry, is prepared. Each scale has all the beauty of a fine pearl, and the reflections from the mailed side of a fish just taken from the water are superb. The scales of the back and the top of the head are of a purplish blue. The blotch of black upon the scapular region, just above the origin of the pectoral, is very constant, although I have seen fish in which it did not occur. Many, especially the older and fatter ones, have a number of irregular, roundish, blue-black blotches upon the sides and flanks. The young fish are not so brilliantly colored, and, in general appearance, resemble the young of the shad.

Color of Southern fish.

48. Many of the Southern fish show metallic, brazen, and golden reflections from the flanks and fins. Agassiz's *Clupanodon aureus*, from Brazil, was similarly colored. The name "yellow-tail," commonly applied to this species in the Southern States, is in common use as far north as Cape Hatteras.

Axillary appendages.

49. In the axils of the paired fins are long differentiated scales, which cover the angles of the fins, and are evidently intended to promote swift

progression in the water. Those attached to the pectoral are often nearly as long as the fin itself. A series of large shield-like scales cover the bases of these fins, apparently with the same object as the axillary scales. These are particularly large in the species from the Gulf of Mexico.

Scales.

50. The scales are, in the young fish, arranged in comparatively regular rows. In adult specimens of the *Brevoortia tyrannus* all semblance of regularity disappears, and it is impossible to count either longitudinal or vertical rows. The number of scales is enormously increased, apparently by the growth of additional scales in the interspaces between those already arranged in regular order. The number of scales in the longitudinal rows is from 60 or 70 in young individuals, to 110 in adults; in the vertical rows, 25 or 26.

10.—INTERNAL ORGANS.

Gill-strainers.

51. There are no vestiges of teeth in the mouths of any members of the genus *Brevoortia*. These fish do not feed upon living animals, and teeth would be useless to them. Their place is supplied by an arrangement of setiform appendages, attached to the anterior edges of the arches supporting the gills. These are closely set, flexible, and in *Brevoortia tyrannus* about 170 in number on each side of each of the arches. There being thus four rows upon each side of the mouth, there must be in the mouth of the menhaden from 1,400 to 1,500 of these thread-like bristles, from one-third to three-quarters of an inch long. These may be so adjusted that they form a very effective strainer, much resembling that of the right whale. This strainer is much finer and more effective than in the whale, the number of bristles being much more numerous than are the plates of baleen in the mouth of the right whale. The uses to which this strainer is applied will be discussed below, in paragraphs 119-125.

The accessory branchial organ.

52. There is also a curious accessory branchial organ, situated between the top of the fourth branchial arch and the base of the skull. This has been described from dissections of a fish identified as *Clupanodon aureus*, Spix, in a paper by Prof. Joseph Hyrtl,* cited in full in the Bibliography.

The alimentary canal.

53. The alimentary canal in the menhaden is peculiar. The pharynx is continued, in a straight canal, to the point of the siphonal stomach, which extends backward nearly to the posterior extremity of the intestinal cavity, then turning at an acute angle returns nearly to the

* Denkschriften Kaiserl. Akad. Wiss. Mat.-Nat. Class, vol. x, 1855, p. 49.

head, where it expands into a globular pear-shaped muscular organ with thick walls, which have their inner surfaces rugose, like those of the gizzard of a gallinaceous bird. At the anterior end of the stomach is a mass of fine, filiform, pyloric appendages, surrounding the origin of the intestine, which is very long and is arranged in two coils, one upon each side of the stomach, enveloping it completely. The length of the intestine is five or six times that of the whole fish.

The swim-bladder.

54. The swim-bladder is small and inconspicuous. Its walls are thin. It is not probable that it contains enough gelatine to be of commercial importance. Hyrtl was unable to detect its presence in the fish studied by him as *Clupanodon aureus*, but which was probably something very different.

III.—GEOGRAPHICAL DISTRIBUTION AND MOVEMENTS.

11.—GEOGRAPHICAL RANGE.

Limits in 1877.

55. It is not easy to define exactly the boundaries of geographical range for any species, unless they be marked by some impassable boundary. It is especially difficult in the case of fishes. The limits of their wanderings appear to depend directly or indirectly upon temperature, and to vary considerably, from season to season, with the seasonal variations in the mean temperature of the water.

As nearly as it can conveniently be expressed the range of the northern menhaden, *Brevoortia tyrannus*, is as follows: it is to be found at some period during the year in the coastal waters of all the Atlantic States from Maine to Florida (approximately between the parallels of north latitude 25° and 45°); on the continental side it is limited approximately by the line of brackish water; on the ocean side, by the inner boundary of the Gulf Stream. What may be the limits of its winter migrations it is impossible to say. A surface temperature of about 51° is necessary for its appearance in waters near the shores.

Variations of the northern limit in the past.

56. Its northern limit of migration seems to have always been the Bay of Fundy. Perley, writing in 1852, stated that they were sometimes caught in considerable numbers in weirs within the harbor of Saint John's, N. B.*

*Descriptive Catalogue (in part) of the fishes of New Brunswick and Nova Scotia, by M. H. Perley, esq., Her Majesty's emigration officer at St. John's, New Brunswick. (Second edition.) Fredericton: J. Simpson, Printer to the Queen's Most Excellent Majesty, 1852, p. 30.

Mr. G. A. Boardman, of Calais, Me., informs me that large schools have been seen during the summer in Passamaquoddy Bay and the lower Bay of Fundy.

James Lord, of Deer Island, Charlotte County, N. B., testified before the Halifax Commission that he had taken porgies in the neighborhood of Campo Bello, but that none had been seen there for ten years or more.*

Mr. J. F. Whiteaves declares that of late years none have been found in New Brunswick, nor to the north of Grand Manan.†

The claim of Professor Hind that they have been found as far north as Canso, is not, to my knowledge, supported by satisfactory evidence.

At present the eastward wanderings of the schools do not appear to extend beyond Isle au Haut and Great Duck Island. These islands are less than forty miles westward of the boundary of Maine and New Brunswick.

Southern limit of range.

57. Dekay supposed the southern limit of the menhaden to be in the neighborhood of Chesapeake Bay, but it has for some years been known that they occur in great abundance on the coast of North Carolina. I found them to be abundant in the Saint John's River, Florida, in March and April, 1874 and 1875, and it is quite certain that they are found there throughout the winter. In the National Museum are specimens (Catalogue No. 7696) collected at Indian River by Mr. Wurdemann. Mr. Charles Dougherty, of New Smyrna, Fla., tells me that he has observed numerous large schools during the winter in the open ocean off Cape Canaveral and Mosquito Inlet.

Old fishermen from Key West, who are perfectly familiar with the fish, assure me that it is never seen about the Florida Keys.

Oceanic limits of range.

58. Beyond these bounds nothing certain is known. The thorough and indefatigable labor of the twenty years during which Professor Poey has been investigating the ichthyology of Cuba justifies us in taking his word that the menhaden is not found in those waters. It has not been found at any other point in the West Indies, nor is it recorded from the coast of South America, though other species of the same genus have been found there. The investigations of Mr J. Matthew Jones and myself have failed to discover it about the Bermuda Islands, and it appears to be unknown to the fishermen at that point.

Menhaden in the Gulf of Mexico.

59. Mr. S. H. Wilkinson, keeper of Cat Island light-house, Mississippi Sound, writes that no fish resembling the menhaden is found in

* Proceedings Halifax Commission, 1877, Appendix F, p. 245.

† Sixth Report Department of Marine and Fisheries, Appendix U, p. 195.

those waters; and a similar statement is made by Capt. D. P. Kane, of the Matagorda light-station, Texas, who is a native of Maine, and has been engaged in poggy-fishing in that State. He has for the past eight years been engaged on the coast from Florida to Mexico, and has never seen menhaden or heard of their being caught south of Cape Hatteras, with one exception.

Capt. William Nichols, pilot, residing in Saluria, Tex., informed Captain Kane that in September, 1872, great quantities of pogies drifted upon the beach at Saluria, and that the waters of the Gulf of Mexico and Matagorda Bay were full of them. Capt. William E. Spicer, of Noank, Conn., is positive that he has encountered schools of these fish while seining for the Mobile market off Tampa, Fla.

These statements probably refer to the Gulf menhaden, recently discovered at various points in the northern Gulf of Mexico, and easily distinguished from the northern species.

Range of other species.

60. On the coasts of Brazil and at Montevideo occurs a geographical race of our northern species, the *Brevoortia tyrannus, aurea*, while still farther south, in the waters of Buenos Ayres, is another species, *Brevoortia pectinata*. The latter was first taken by Charles Darwin, on his memorable voyage around the world, in a net on a sand-bank at Bahia Blanca (latitude 39° S). Very probably the species is abundant along the coasts of the Argentine Republic, in the broad mouth of the Rio de la Plata, and from the analogy of our species, well up the southern coasts of Brazil, perhaps to Rio Janeiro. It is not unlikely that the eastern coast of South America is as abundantly supplied as our own with these most valuable fishes. Valenciennes states that the Portuguese of South America call the *Brevoortia aurea* by the name *Savega*.

Again, on the coasts of West Africa occurs a species, *Brevoortia dorsalis*, closely resembling the menhaden. An old fisherman in Maine told me that he had seen the menhaden in immense quantities on the western coast of Africa, where the negroes spear them and eat them.

Illustrations and descriptions of all the known American species are given elsewhere in this memoir.

Alleged occurrence on the Pacific coast.

61. The Hon. S. L. Goodale, of Saco, Me., writing under date October 25, 1877, states that some menhaden fishermen of Bristol, Me., have recently sent one of their number to prospect for them on the Pacific coast, and that his reports were so favorable that several of them with their families had left a few weeks previously for Washington Territory, where they were informed that "pogies" were abundant. If this report be true, it is quite certain that the explorers are doomed to disappointment. No fish resembling the menhaden occurs in the Pacific Ocean.

It should be noted, however, that wherever representatives of this genus of fishes occur there is doubtless an opportunity for establishing new industries of great value. It would be well worth while for enterprising fishermen to investigate this subject. The Government of Japan has recently employed one of the best informed of our New England fishermen * to instruct the natives of that country in the arts of catching and preserving food-fishes.

As has already been stated, there are abundant supplies of these fish on both sides of the South Atlantic. There is apparently no reason why extensive manufacturing interests may not be inaugurated in Brazil, the Argentine Republic, Paraguay, and Africa.

12.—THE ARRIVAL AND DEPARTURE OF THE SCHOOLS.

Causes influencing times of arrival and departure.

62. The date of the earliest appearance of the schools of menhaden at any given point upon the coast corresponds very closely with that of the arrival of scup, shad, bluefish, and other of the non-resident summer species. It depends primarily upon the temperature of the water. This element is of more importance, perhaps, in the case of the menhaden than with the carnivorous fishes, since the food-supply of the former is not likely to be affected by changes of temperature. There are other questions to be considered, such as the movements of hostile species and the direction of the prevailing winds, though the latter may, perhaps, be merged in the question of temperature. Their departure is regulated by the same causes, though, since their food-supply is less uncertain, they linger later in our waters than most of their companion species of the spring.

Material available for the determination of dates.

63. The material for determining the movements of the schools is very unsatisfactory, though perhaps of necessity so. Although many of our correspondents give dates of arrival and departure, these are understood to be merely approximations to the truth. The only series of observations showing the dates of the arrival of menhaden for a period of several successive years is one from the Waquoit weir, and this professes to show nothing except the date at which the fish began to be abundant. In the nature of the case, observations of a more definite nature are impracticable. Since so little that is definite can be recorded, it may be desirable to review the statement, of some of our correspondents, thus putting on record a series of observations all carefully made and many of them extending over a long period of years. In this way the movements of the menhaden at different points upon the coast will be described more accurately and graphically than they could be by any compiled account, however carefully it might be prepared. It is

* Capt. U. S. Treat, of Eastport, Me.

hoped, too, that this course may suggest and elicit fuller observations from persons living in our seaboard towns.

A review of the general movement along the coast.

64. At the approach of settled warm weather the schools make their appearance in the coast waters. They remain in the bays and near the shores until they are warned away by the breath of coming winter. The date of their appearance is earlier in the more southern waters, and the length of their sojourn longer. It is manifestly impracticable to give anything but approximate dates to indicate the time of their movements. In fact, the comparison of two localities, distant apart one or two hundred miles, would indicate very little. When wider ranges are compared there becomes perceptible a proportion in the relations of the general averages. There is always a balance in favor of earlier arrivals at the more southern localities. Thus, it becomes apparent that the first schools appear in Chesapeake Bay in March and April, on the coast of New Jersey in April and early May, and on the south coast of New England in late April and May, off Cape Ann about the middle of May, and in the Gulf of Maine about the latter part of May and the first of June. Returning they leave Maine in late September and October, Massachusetts in October, November, and December, Long Island Sound and vicinity in November and December, Chesapeake Bay in December, and Cape Hatteras in January. Farther to the south they appear to remain more or less constantly throughout the year.

Coast of Florida.

65. In the Saint John's River, Florida, menhaden are abundant throughout the winter. They appear in November clogging the shad-nets. It is not known how far they proceed up the river, but I was unable to learn that they have been taken above Buckley's Bluff, twelve miles above Jacksonville and thirty-six from the mouth of the river; they are particularly numerous at the mouth and in the vicinity of Mayport and Yellow Bluff. That they remain as late as May is well established, and it is the opinion of Mr. Kemps that they are found throughout the summer, the young fish, at least. I have found the grown and half-grown fish abundant at Arlington and Jacksonville in April, 1874 and 1875. After the first of May the opportunities are not favorable for observation, the use of shad-nets being then discontinued. Young fish are seen from May to October, according to Mr. Kemps, in schools over two miles long and extending from shore to shore of the river. Along the coast of Florida, from Cape Canaveral north, the schools of adult fish are said to be common through the winter months.

Coast of Georgia.

66. Mr. Joseph Shepard, of Saint Mary's, Ga., states, on the authority of a Saint Andrew's Bar pilot, that small schools of menhaden are seen in Saint Andrew's Sound during the summer months, coming over

the bar with the flood tide and going out with the ebb, and that the same fish are also seen in large schools in calm weather during the winter months outside the Sea Islands in about seven fathoms of water, and three to four feet below the surface. Mr. Charles C. Leslie, a fish-dealer in Charleston, S. C., informs me that schools of menhaden frequently are seen in the winter off Charleston Harbor; a statement which is confirmed by others, among them Mr. Daniel T. Church, of Rhode Island.

Coast of North Carolina.

67. Mr. A. C. Davis, of Beaufort, N. C., writes that the fat-back first approaches the coast at that place in June, the main body arriving in July from the south, entering the rivers and drifting up with the flood tide and down with the ebb; their appearance is regular and certain, and has never failed, the numbers seeming to be greater every year. They remain in the rivers and inlets throughout the summer, gradually departing toward the close of October and the first of November to the southward. During the season they are constantly coming in at intervals. Those which first arrive are one-quarter to one-half grown, no full-grown fish appearing until later in the season. In bad weather, especially with northern winds, they leave for the sea, returning in moderate weather, with southerly winds.

Mr. A. W. Simpson, jr., of Cape Hatteras light-station, records several interesting facts concerning the movements of the fat-back around that cape. They first make their appearance in June and remain until December; they generally come in to the shore on the northern coast of the cape, running south along the beach and entering the inlets and rivers. In the first of the season they may be seen, in moderate weather, five or six miles at sea, in large schools half a mile in length, apparently floating upon the surface of the water. They always make their appearance from the north and leave the coast by the same route. Some are seen in the sounds and rivers all the year. When the second large run occurs in the fall they appear in immense numbers. This is sometimes in November and in other seasons in December. In 1873 they were first seen on the coast about the 6th of December, and the main body arrived about the 10th of December. Many schools may be seen at one time. They seldom come near the coast in high winds and rough seas, or if they do they swim so low that they are not seen from land. Their appearance is certain and they are about the same in abundance every year at the spring run, but the fall and winter runs vary somewhat, the number in some seasons being very much smaller. Mr. Simpson thinks that the tides do not affect their movements in any respect, except that they prefer to swim against the tide; he has convinced himself, by careful observation, that more enter the inlets on the ebb than on the flood, though they are frequently seen drifting up and down channels with the flood and ebb. The one and two years' fish school by themselves, the young in large schools along the sandy shores. Many fish pass the winter in the inlets and rivers,

but most of them leave the coast by a northern route, the spring runs leaving in October, the fall runs about the middle of January. Some seasons they go to sea in large schools and others they drop away gradually. The first of the spring-runs are usually the smallest. During the summer the large schools are only seen occasionally, though Mr. Simpson thinks that they are on the coast continually. They only come near the outer sea-beach when driven in in October and November by the tailor (*Pomatomus saltatrix*), or blue-fish of the North, and the dog-fish (*Mustelus lavvis*).

Coast of Virginia and Chesapeake Bay.

68. According to Mr. Henry Richardson, the alewives are caught in the vicinity of Cape Henry as early as March, though the main body does not come in until June and July. During these months they are constantly passing the Virginia capes and entering Chesapeake Bay, coming from the south.

The Potomac fishermen inform me that they appear in the spring soon after the shad and herring, remaining in the Potomac during the season, where they prove a serious hinderance to the working of the shad seines. Young fish seven inches in length were taken in the lower Potomac at Nanjemoy Reach as late as December 10, 1874, but disappeared after the first heavy frost. The first schools appeared late in March and early in April, 1875, and in 1878 early in March.

At Apateague Island, Accomac County, Virginia, according to Mr. J. L. Anderton, they are first seen swimming northward near the coast in April, the main body arriving in June. Their appearance is regular. They run in-shore on the flood, drifting off with the ebb. In November they are seen making their way toward the south.

In Tangier and Pocomoke Sounds, says Mr. Lawson, they appear about May 1, the fish of different sizes in separate schools; they are found there in quantity throughout the season, the southward migration beginning in August and continuing until the middle of October.

I find a manuscript note by Professor Baird to the effect that they are found in large schools at Cape Charles, Virginia, from April to October, being most numerous on the bay side of the peninsula.

Delaware Bay.

69. Mr. James H. Bell, keeper of Mispillion River light-house, Delaware Bay, states that fish are first seen in those waters early in March, and grow more numerous until about the middle of April, when they are frightened away by the sea-trout. They soon return in increasing numbers until the middle or last of May, after which they begin to disappear in large schools until the first of August, when they again become numerous, and continue so if the weather is mild, when they begin to disappear, working out to sea through the channel. The opinion of Mr. Bell is that after entering the bay they follow the main channel, spread-

ing toward the shores on either side as they advance, until arrested by brackish water. The western shore of the bay is very shallow, the tide near the beach seldom rising above six or seven feet. When the tide is three-quarters flood the fish run in close to land and are caught within twenty yards of the beach; from slack water to first quarter ebb, if it is calm, the water is spotted with the break or ripple, and as the tide recedes they float out with it to deep water. Medium and small fish are found together, not probably in the same schools, but close enough together for the seine to catch fish ranging in length from three to nine inches.

Coast of New Jersey.

70. According to Mr. Albert Morris, menhaden make their appearance in Great Egg Harbor, New Jersey, about May 1, the main body arriving about June, and leaving about the middle of September, the "eastern run" coming along in October or November.

Mr. A. G. Wolf, keeper of Absecom light, Atlantic City, N. J., writes that the appearance of the first schools is regular and takes place in April, the main body coming in July. They come from the returning south by degrees in the fall, beginning in September.

D. E. Foster, of Cape May light-house, states that they appear from the south about April, larger but not so fat as the second arrivals in July, the majority of which are from four to six inches in length. They disappear in November, heading to the north.

Eastern end of Long Island.

71. In the vicinity of Greenport, N. Y., according to Captain Sisson, the first arrivals are in March and April, and according to Mr. Havens, about April 1, while Hawkins Brothers, of Jamesport, put it about the 1st of May. These gentlemen agree that the first schools contain the largest fish; that they are followed for some weeks by other runs, and that the schools leave for the south on the approach of cold weather in October and November.

Mr. Dudley tells me that his steamer usually starts out from Pine Island from the 1st to the 12th of May. She never fails to find fish outside of Montauk Point. The gangs which started out for the season, April 29, 1877, found plenty of fat fish on the first day out.

The late schools of large fish which come upon the Connecticut coast about the 1st of November, and which are supposed to come from the coast of Maine, usually strike across from Watch Hill and Fisher's Island to the Napeague shore, where they sometimes remain several days before their final disappearance from those waters.

Long Island Sound.

72. In the western part of Long Island Sound, at Stratford, according to Mr. Lillingston, they appear about the 1st of May and remain until Octo-

ber, when they leave at once, swimming east. They approach from the east. The largest fish he thinks are found in August. In August and September immense numbers "strike on" and follow up the Housatonic River, and these are invariably poor.

At Milford, Conn., we are informed by Mr. Miles, the first white-fish are seen in April or May, the main body arriving in Long Island Sound in June and July. Sometimes the first fish are the largest. The schools or runs appear to come at intervals of from two to three weeks. The fish come in around Montauk Point, the early fish follow along the Connecticut shore and up the rivers; later in the season they are found offshore in deep water, though they occasionally work inshore and up the rivers. Their appearance is regular and certain. The schools are mixed as regards size, in the opinion of Mr. Miles. The schools begin to disappear about the 1st of September, passing around Montauk Point to the south, and are all gone by the 1st to the 15th of October.

At Westbrook, according to Captain Stokes, they appear about the middle of May and leave in November in continuous schools, passing around Montauk, bound to the south. In July the schools are the largest.

At Saybrook, says Captain Ingham, the first bony-fish are seen in May, the main body arriving in June. The first are scattering and generally the largest; there are several runs at irregular intervals. The appearance of the fish is regular and certain. They leave in October mostly in a body.

Captain Beebe, of the Cornfield Point light-vessel, writes that the first bony-fish are seen in April, but that these are not the largest. They work along the bays and rivers of the sound, drifting in with the flood and out with the ebb. They leave about the middle of November in a body, passing around Montauk Point to the southward. They ascend the Connecticut above the Shore Line Railway bridge, where they are often followed by the seining gangs belonging to Luce Brothers, of Niantic.

Block Island Sound.

73. Captain John Washington, of Mystic River, Conn., states that the first bony-fish arrive in Block Island Sound early in April, followed by larger schools toward the last of the month, and that they continue to come in during the first half of the summer. They come in around Montauk in large schools, and after passing the outer islands, the large schools break up into smaller ones, which make their way toward the rivers and coves. Their arrival is certain and quite regular, varying but a few days from year to year. They begin to leave in October, and by the last of November are gone. A few stragglers are seen in the Mystic River until the beginning of freezing weather. They swim southward in their fall migration, going faster than when coming north in the spring.

Capt. Jared S. Crandall observes that they first appear in Block Island Sound about May 1, coming from the southward and through the east

end of Long Island Sound, working to the eastward and westward. Their appearance is certain, though their abundance is greater in particular seasons. They leave gradually in November and December, working to the westward after leaving the sound. Small and large are mixed indiscriminately in the schools.

At Block Island, according to Mr. Henry W. Clark, they appear about the 1st of May, and continue running in until about the middle of June. Their appearance is certain but their number variable. They work in and out with the tide, but when they are making a passage the tide does not stop them. They start southward about the middle of October, and continue running for a month.

Mr. Dudley on the schools of Eastern Connecticut.

74. Mr. Dudley, whose vessels ply their nets in both Block Island and Long Island Sounds, tells me that fishing begins at Pine Island from May 1 to May 12, and that for quite a number of years fish have been taken the first day the vessels went out. In 1877 the vessels which started April 20 found plenty of fat fish. Whether the season be hot or cold, the fish come at about the same date. Of late years the first schools have been very fat; immediately followed a run of poorer fish. The run which begins in the middle of April and continues for three or four weeks, is composed of fish yielding from five to seven or eight gallons to the thousand. The next run of fish continues until about the 1st of July. These yield not over four gallons. Then follows a poorer run, averaging two gallons. In 1877 millions of fish have been taken which have not averaged above one quart to the thousand. In 1876 it was much the same, but in July, when the poor fish were most abundant, a few schools made their appearance which yielded ten gallons to the thousand. Of two gangs, fishing side by side, one might make a haul of ten-gallon fish, while the other secured only half-gallon fish. Good fish are usually expected in the fall. In 1876, however, they were few and poor. In 1877 the schools of fat fish made their appearance near Point Judith on the 30th of October.

Narragansett Bay.

75. At Point Judith they come in from the westward, according to the statement of Joseph Whaley. They appear about the 20th of May, and continue to pass, moving eastward, until July. Their arrival is very regular, but sometimes cold weather and easterly winds put them back ten or fifteen days. They begin to leave in October.

Mr. Daniel T. Church, of Tiverton, R. I., states that the menhaden make their appearance in Narragansett Bay about May 1, and continue running in during the season; their arrival in Narragansett Bay for the past eighteen years has been certain, though the time of arrival varies with the weather; they drift with the tide at times, and at others swim against it. No fish are taken in the purse-nets after the cold weather

of the fall, but the gill-nets often take them as late as New Year's. Benjamin Tallman caught 1,600 barrels (400,000) on December 3.*

Martha's Vineyard Sound.

76. At Menemsha Bight the menhaden appear from April 21 to May 10, according to Jason Luce & Co., and swim west. Mr. Marchant, of Edgartown, thinks that they enter the Vineyard Sound from the south-west. It is more than likely that both are right, and the fish enter the sound at either end indifferently. They are seen here in November.

According to Captain Edwards, menhaden come to the vicinity of Wood's Holl, Massachusetts, in May, and remain until October. Captain Hinkley, of the same place, states that they first appear to the westward, striking Montauk Point and following along the coast exactly like the scup, but going more into the bays; they go in more shallow water; he has seen them in 12 feet. A school looks reddish. He has seen a school a mile wide and a mile and a half long. They frequently swim near the surface and make a ripple that can be seen. The first school swims rather deep, but as they become more plenty they can be seen. They generally come in about the 10th of May; in 1871 the first were taken the 21st of April, about three weeks earlier than the average. But they strike off again for about a fortnight before they come regularly.

Capt. Isaiah Spindel, of Wood's Holl, took the first menhaden of the season of 1870, April 23, and the first mackerel at the same time; these were only stragglers, and the best time for catching menhaden that year was about the 10th or 15th of May; in 1871 they came on the 21st of April, when a thousand were caught; a few stragglers had been taken before, perhaps as early as the middle of April. In 1872 no menhaden were seen after the 15th of October.

In the autumn of 1877, which was unusually late and warm, the menhaden lingered on the coast until very late. Vinal Edwards saw many taken, November 28, by the North Truro fishermen, and himself found them at Wood's Holl, December 1.

A very definite idea of the date of appearance of the menhaden in the Vineyard Sound may be gathered from a table given in the Report of the Massachusetts Commissioners of Inland Fisheries for 1871, and here reproduced with additions for convenience of reference.

* Report of the U. S. Commissioner of Fish and Fisheries, 1873, p. 184.

77. Table showing days of first appearance in abundance of menhaden, alewives, scup, and bluefish, at Waquoit weir, since 1859.

Year.	Menhaden.	Alewives.	Scup.	Blue-fish.
1859.....	May 6	April 7	May 5	May 16
1860.....	May 4	April 3	May 2	May 15
1861.....	May 1	April 1	April 27	May 17
1862.....	May 6	March 30	May 10	May 13
1863.....	May 2	March 29	May 8	May 15
1864.....	May 5	March 28	May 6	May 17
1865.....	May 1	March 29	May 1	May 16
1866.....	May 7	April 2	May 8	May 15
1867.....	May 3	March 28	May 4	May 14
1868.....	May 15	March 30	May 10	May 19
1869.....	May 10	March 31	May 7	May 17
1870.....	May 8	March 28	May 2	May 11
1871.....	April 21	March 24	April 25	May 24

Irregularities of movements shown by returns of Waquoit weir.

78. The returns of Waquoit weir, which was rented in 1871, by the Massachusetts commissioners of inland fisheries, for the purpose of getting exact statistics on the subject of pound-fishing, show how uncertain and irregular are the movements of the menhaden and their capture in any fixed locality upon the shore. April 21, 1871, 6,000 were taken; April 23, 13,300; May 1, 17,420; May 5, 35,920; May 9, 10,020; May 10, 16,800; May 11, 14,945; May 13, 14,200; May 15, 7,300; May 16, 900; May 18, 1,280; May 19, 1,040; May 20, 7,600; May 22, 6,000; May 23, 26,000; May 24, 2,205; May 25, 780; May 31, 40,300; June 1, 13,260; June 10, 7,540; June 14, 27,300; June 16, 93; June 17, 19. In 1865, from April 21 to May 15, were taken 175,300, and from May 16 to June 2, 35,800; in 1866, between these dates, respectively, 213,730 and 104,780; in 1867, 82,680 and 121,060; in 1868, 45,706 and 79,920; in 1869, 66,680 and 79,030; in 1870, 152,590 and 255,340; in 1871, 136,005 and 99,256.*

South shore of Cape Cod.

79. At Hyannis, Mass., writes Mr. A. F. Lathrop, they appear in May in small numbers, the greatest season of plenty occurring in June. They work along the shore line and into the sounds, bays, and rivers. Their appearance is regular and certain, and they disappear in a body about the 1st of October.

Capt. Reuben C. Kenney, of Nantucket, Mass., states that they appear in the vicinity of that island about the 1st of May, or a little earlier if the season be favorable. They appear to come from the direction of Sandy Hook and the coast of New Jersey. They are most abundant in June and July, and begin their return in October, all disappearing in November.

Capt. Josiah Hardy second, of Chatham, Mass., writes:—"The menhaden seen here are on their route to the eastern shores, coming from

* Report of the Massachusetts Commissioners of Inland Fisheries for 1871, and Report of United States Commissioner of Fish and Fisheries 1871-72, pp. 174-176.

the west; when they strike Chatham Bay they swim in large schools, coloring the water and followed by numerous sea-birds. They are governed by the winds and weather about showing themselves; in fine moderate southerly weather they come up on top of the water. They have been caught in our bay as early as the 15th of April, but generally not before the 1st of May. I never knew them to fail coming; they generally follow the shores, making their way down the sound by Monomoy Point, and those that get within the point, into the bay, follow the shore to get out on their transit east. There is no difference in their size in the spring, or a very slight one in some schools. In our bays, ponds, and rivers they will head the tide; they come inshore at high water on this coast and at low water keep off the flats and shoal water into the channel or deep water, which is from three to seven fathoms in our bay. I do not think it makes any difference to them about the depth of water; they seem to have a natural instinct, and are just as regular in their course and movements as a flock of sea-fowls; when one is frightened they all start, if one turns all in the school turn, if one goes down all in the school follow. One peculiar trait in them that cannot be accounted for is, that on this coast, as well as on the eastern shore, sometimes for hours there is not a fish to be seen, then all at once they rise to the surface and it is literally full of schools, sometimes turning in a complete circle, at other times all headed one way, then all at once every one has disappeared. The fish pass here (the cape), bound south, in the latter part of September and the first part of October, all moving about the same time. Sometimes in their transit south they find their way into our ponds and creeks and get bothered and belated; they chill very quick in a cold night. Their route south is outside of Nantucket Island."

Cape Cod Bay.

80. Mr. David F. Loring, keeper of Highland light, at the northeasternmost point on Cape Cod, states that pogies appear in that vicinity from the last of April to the middle of May, making their appearance in large schools on the surface. After passing by the cape in the spring, they frequently throughout the summer make their appearance in Provincetown Harbor, the bluefish chasing them. They are very seldom seen to school on the ebb tide, but as soon as it turns flood they are seen on top of the water. Mr. Loring states: "I have seen the surface of the water literally covered with schools on the flood tide, while on the ebb there is hardly a fish to be seen. I have seen them under water on the ebb tide, two or three fathoms down, in schools, but they move very slowly until the tide turns flood. Then they school up to the surface of the water and are quicker in their movements. I have seen them in the fall of the year when not schooling, but whether schooling or not they generally play on the surface of the water, except on the ebb tide." They commence to leave the coast about the 1st of October, moving south by

degrees. During the month of November, 1874, the small seining steamers belonging to an oil and guano company in Fall River, Mass., which has a large factory in Boothbay, Me., having left the Maine fishing-grounds after the pogies had left the coast, fell in with large schools just outside of Provincetown Harbor and took 30,000 barrels of them in a short time.

According to Mr. Heman S. Dill, light-keeper on Billingsgate Island, pogies appear in Barnstable Bay about May 10, not varying over four or five days from year to year.

Vicinity of Cape Ann.

81. At Marblehead, Mass., we are informed by Mr. Simeon Dodge, the fish appear about May 9, a larger body appearing in July; their course is northward, their appearance certain. Their favorite locality is at the mouths of fresh-water streams, moving up the creeks with the flood and and down with the ebb. They take their departure in a body about the last of October.

Capt. F. J. Babson, of Gloucester, Mass., states that the appearance of this fish for the past thirty years has been regular and certain. They first appear in Massachusetts Bay about the 15th of May, and are present in the greatest numbers a month later. When in deep water they are not affected perceptibly by the tide, but when near the shore run in and out of the rivers and creeks with the tide. They swim low during easterly winds, but in warm and pleasant weather play at the surface. They begin to leave the coast about October 1, and by the last of the month are all gone.

Gulf of Maine.

82. According to Judson Tarr & Co., they come on the coast of Maine about the 1st of June, though they are not plenty until June 20; they continue coming until July. They follow the shore coming and going, and their appearance is certain; they have never been known to fail. They leave the coast about October 1, on the approach of cold weather.

Mr. J. Washburne, jr., of Portland, Me., states that pogies appear in that vicinity June 10 or 15. They come in two schools; the first, which are small, usually come about ten days before the second school. They remain during the summer and work in shore on the flood tide and out on the ebb. They leave for the South about October 1; in 1874, some were taken November 4.

Mr. G. B. Kenniston, of Boothbay, Me., who is largely engaged in the menhaden fisheries, thus gives the result of his personal observations: "The pogies are first seen about May 20 in occasional schools. The main body arrives about June 20, which, passing to the eastward, is followed by others continually for about thirty days longer. There is considerable difference in the size of the fish caught. At times, mixed sizes are taken at the same set. Usually those arriving at different periods differ

in size, the larger may come sooner or later; nothing certain is known as regards this. After rounding Cape Cod, some touch the coast in the vicinity of Gloucester, Mass., but by far the larger portion it appears keep off shore, and near it anywhere from Cape Elizabeth to Monhegan. The main body of these fish continue to pass toward the east till about the 20th of July, when that impetus seems to be checked, and for thirty or forty days their movements are seemingly local. Then they begin their return to the west, and continue to re-pass until in October. The last bodies are urgent in their westward course. Their appearance is regular, and they have never been known to fail. The temperature of the air affects them; they will not 'show' or come to the surface when cold north or east winds prevail."

Boardman and Atkins state that the latest date at which menhaden have been observed on the western coast of Maine, between Cape Elizabeth and Pemaquid, is October 25, and the period of greatest abundance about the last of July or the first of August, although for several weeks preceding and following that date, there is little variation in their number. Since the publication of his report Mr. Atkins has observed small menhaden as late as December in the vicinity of Bucksport.

Mr. Benjamin F. Brightman, of Round Pond, Me., also largely interested in the fisheries, states that the first fish make their appearance about the 1st of June, though usually scattering. Seining begins about the 15th; the fish are poor then and rather smaller than those taken in August and September, when the smacks go off shore from five to thirty miles to get larger and fatter fish. Seining begins about the 15th of June, and continues until the 15th of October. They are most abundant and easily seen on a warm, sunshiny day. The fish start to go west about the middle of September, and continue going until the last of October.

Mr. John Grant, keeper of Matinicus Rock light-station, writes that they arrive about the 1st of June, the larger body from the middle to the last of June, the last school being much the largest and fattest. There are commonly several schools at irregular intervals. A favorite playing-ground is between Seguin Island, and Matinicus Rock, and in the bays and mouths of rivers between those two points. The fish leave about the middle of October in a body.

On the eastern side of Penobscot Bay near Brooklin, according to Messrs. J. C. Condon and R. A. Friend, pogies come in from the 10th to the 15th of June, and leave by degrees after the 1st of October. They are most abundant in June and July.

In the same vicinity, according to Mr. Z. D. Norton, the first menhaden seen are scattering individuals that are caught in gill-nets and wears in May, often as early as the middle of the month. The schools do not appear until the middle of June, on an average. They leave in September commonly. In Bluehill Bay they are sometimes known to stay as late as October.

Mr. William H. Sargent, of Castine, Me., has known them to come in as early as May 25, and has seen them in November.

Eastward from this point the stay of the menhaden is materially shortened up. At Jonesport, according to Mr. George R. Allen, it is almost confined to the month of August, scattering ones being taken in July. In Passamaquoddy Bay and vicinity menhaden are now rarely seen. Formerly they were found in all these waters in August.*

Mr. Maddocks on the Maine schools.

83. Mr. Maddocks states: "Its appearance on the coast of Maine is from about June 1, to October 1. The date of coming rarely varies more than five days; that of departure is sometimes delayed until October 15, if the weather continues mild and calm. It usually disappears from the surface during the continuance of cold northerly winds; and even in favorable weather alternately rises and sinks during the day, the morning and evening being the time of most general appearance. The first straggling comers are generally discovered on the 'outer grounds,' so called, some forty miles off shore. The numbers increase with the advance of the season, the fish gathering in schools or bunches from the size of a dining table to ten acres large, and fifty of these being frequently visible at once from the mast-head. In these bunches the fish extend from the surface two or three fathoms deep, more or less, as far at least as can be seen, in a compact mass, either lying perfectly still or moving slowly with their heads all pointed one way as if intently gazing upon an object before them."† And again: "It is certain that the disappearance of the menhaden from the Maine coast in the autumn is accomplished by a movement of vast numbers (not necessarily the whole or even the greater number) to the west and south along the shore. The withdrawal is nearly simultaneous, but in a body so immense that the vanguard reaches Cape Cod before the rear has left the Maine waters. Our fishermen follow the retreating army as far as Cape Cod and Sandy Hook, and make large captures."

13.—MIGRATIONS.

Migrations of fishes and their causes.

84. It was formerly believed that all seasonal migration was directed toward and from the equator, but zoologists of the present day recognize another kind of migration quite as important although not usually so extended. At the approach of the hot season in subtropical climates the birds seek a cooler temperature, either by flying northward or by ascending the high mountains. In like manner the fishes of any region may find water of suitable warmth by moving north or south along

* Goodale & Atkins, op. cit., p. 4.

† The Menhaden Fishery of Maine, p. 4.

the shores of the continent, or by changing to waters of less or greater depth. The former may be called equatorial, the latter bathic migration.

Bathic migration is the most common. The cod family, the halibut, and flounders, the scuppaug, tautog, sea bass, and sculpins, are well known examples. The cod prefers a temperature of from 35° to 42° F. and this it secures in a temperate climate, such as that of Southern New England by remaining on the off-shore banks in 15 to 30 fathoms of water, coming near the shore in winter. On the coasts of Labrador, Newfoundland, Nova Scotia and Eastern Maine they are near the shore in summer and in deep water in winter. In Norway the fish are caught to some extent in the fiords in the summer season, though more in winter. In summer they still remain on the off-shore banks. The halibut moves up and down on the sides of the great oceanic banks and the continental slopes, with the seasonal changes of temperature. In summer they are abundant in the shallows of South Greenland, while in winter they are in deep water. On the coast of Massachusetts they come near the shores only in the dead of winter, though abundant in summer on the edges of the outside banks in 80 to 300 fathoms of water. The sand dabs (*Hippoglossoides dentatus*) are abundant in July in water of 60 and 80 fathoms ten miles off Cape Ann; in the middle of winter they swarm upon the sand flats in two or three fathoms depth.

The Spanish mackerel, the bonito, and the tunnies are good examples of nomadic species. In summer they throng our northern waters; in winter they are under the tropics.

Others, like the sea-herring, appear to migrate in two ways. Their movements are, approximately, both parallel with and vertical to the coast line; that is to say, they secure changes of temperature both by leaving the upper strata of the ocean and by moving toward and from the equator. The researches of Boeck in Norway, show that the schools approach the coast by gullies or submarine valleys from the oceanic depths. Such is doubtless the case on our own coast, in their earliest approaches, though having reached the shallows near the shore, the schools range along great stretches of coast line. Since fishes have no restrictions upon their movements except those of food and temperature, all active species must traverse areas of many hundreds of miles during the year.

The tendency of all the researches made during the past few years has been to confirm the views advanced by Professor Baird in an unpublished letter written in 1873 to the Hon. Hamilton Fish, Secretary of State.

"The question in regard to the migration of fishes is one that has attracted the attention of both fishermen and naturalists for many years past, and a great deal of eloquence has been expended by Pennant and other writers, in their history of the movement of herring and other species.

"For many years it was considered beyond question that the sea herring, having their homes in the northern seas, were in the habit of

prosecuting extensive journeys, in the course of which they successively visited the shores of Europe and of America, penetrating into their bays and sounds, and returning afterwards to the point from which they started; the adults decimated by the predaceous fishes and their capture by man, but their numbers kept up by the progeny, the result of their spawning operations, for which purpose it was supposed their journeys were initiated.

"In the same manner the shad and the fresh-water herring of the American coast were supposed to start in the late winter along the southern coast of the United States, in a huge column, the herring first, and afterward the shad, first entering the Saint John's River in Florida, and while passing up the coast sending off detachments into all the principal rivers, and finally stopping in about the latitude of the mouth of the Gulf of Saint Lawrence.

"This theory is at present almost entirely abandoned, and there is reason to believe that after the herring and shad have spawned in the rivers they proceed to sea, and spend the period until their next anadromous movement in the immediate vicinity of the mouths of the rivers, where they are followed in due course of time by their young. This is illustrated by the fact that fish of nearly every prominent river show some peculiarities by which both the fish-dealer and the naturalist can distinguish them; the difference not being sufficient to constitute a specific rank, but such as to mark them as local races. Numerous captures, too, in gill-nets and otherwise, off the northern coast, during the period when they should be gathered together in the southern waters, prove that a portion at least remain. It is difficult to imagine how a shad or a river herring, spawned in the Saint Lawrence River or any northern stream, could avoid entering a more southern river, if in its vicinity; but if any fact has been well established of late years in the history of the fishes, it is that the anadromous fish, or such as run up the rivers from the sea to spawn, will return if possible to the river in which they first saw the light. So true is this, that where there may be two or three rivers entering the sea in close proximity, which have become destitute of shad or herring in consequence of long-continued obstructions, and the central one only has been restocked by artificial means, the fish, year by year, will enter that stream, while those adjacent on either side will continue as barren of fish as before."

The influence of ocean temperature on the movements of menhaden.

85. The influence of ocean temperature on the menhaden is not at all well understood, and I can here record only crude generalizations founded upon very unsatisfactory data. I have before me three tables showing the variations of temperature, by monthly means, for Key West, Fla.; Jacksonville, Fla.; Savannah, Ga.; Charleston, S. C.; Wilmington, N. C.; Norfolk, Va.; Baltimore, Md.; New York City; New London, Conn.; Wood's Holl, Mass.; Portland, Me.; and Eastport, Me. Table I shows

the monthly means of surface temperature; Table II, of temperature at the bottom near the shore; and Table III, the average means of the surface and bottom temperatures. The observations were all made at 3 p. m., and are continuous from March 1, 1876, to March 1, 1877. These are reproduced in Appendix F. There is, also, a table of the daily observations of temperature at the surface at the same stations. A study of these tables, which, for convenience, were mapped out in curves upon section paper, affords some interesting results.

Minimum limits of temperature and the dates of appearance and disappearance of the schools.—The monthly mean of surface temperatures at Eastport is greatest in September, when it is $50^{\circ}.6$, while the highest daily observation is $51^{\circ}.5$. The menhaden do not visit Eastport in mid-summer. Let us divide the monthly averages for May, at Portland, into quarterly periods. The average for May 16–23 is $47^{\circ}.1$; for May 24–31 is 51° . The quarter-month averages for October are $53^{\circ}.8$, $50^{\circ}.8$, $47^{\circ}.9$, $48^{\circ}.8$.

The schools of menhaden arrive in Eastern Maine late in May and early in June, and depart, usually, before the middle of October.

At Wood's Holl the quarter-month averages for May, as taken by the Signal Service observer, are $48^{\circ}.2$, $49^{\circ}.6$, $53^{\circ}.1$, and $57^{\circ}.6$, approximately, or the monthly average, $52^{\circ}.3$. These observations are made in the Great Harbor, at the railroad-wharf. Another series of observations, made by Captain Edwards, for the Light-House Board, in the Little Harbor, are believed to indicate more nearly the temperature of the Vineyard Sound. These, however, are only for bottom. The difference between the monthly mean of bottom temperatures for May, at the two stations, is almost two degrees ($1^{\circ}.8$), the figures being $51^{\circ}.5$ for Great Harbor, for Little Harbor $53^{\circ}.3$. It does not seem assuming too much to place the quarter-month average for the first half of May at 50° and $51^{\circ}.4$. For November the Great Harbor quarter-month means are 51° , 51° , $47^{\circ}.7$, $43^{\circ}.3$.

The menhaden strike into Vineyard Sound early in May or late in April, and linger until November, and even December.

At New London the quarter-monthly averages for the last half of April and the first half of May are 49° , $48^{\circ}.5$, $52^{\circ}.5$, $54^{\circ}.5$; for late October, $55^{\circ}.2$, $54^{\circ}.9$; for November, $53^{\circ}.5$, $51^{\circ}.1$, $48^{\circ}.1$, $46^{\circ}.1$.

The fish come on the eastern coast of Connecticut late in April, and are frequently taken as late as the middle of November. The temperatures of New London suggest that there may be something in error in the Wood's Holl observations in so far as they are supposed to indicate the temperature of the ocean in its immediate vicinity. The periods of appearance and disappearance at Waquoit and Menemsha, in the Vineyard Sound, agree nearly with those of Eastern Connecticut.

The temperature of the Chesapeake must be studied from the observations made at Baltimore and Norfolk. At the latter place the April means are 52° , $56^{\circ}.5$, $61^{\circ}.2$, 60° ; the November means, 59° , $54^{\circ}.6$, $53^{\circ}.5$,

48°.5; at the former for April, 45°.6, 50°, 54°.5, 55°.7; for November, 54°.2, 52°.1, 50°, 47°. At Norfolk the averages for the last half of March are 48° and 50°.

The movements of the menhaden in other waters have not been very carefully observed, but we know that they enter the Potomac late in March and early in April, and that they linger till the last part of November.

In 1874 the young menhaden lingered in the Lower Potomac until the middle of December. In 1876 the average for December surface temperature at Norfolk was 36°.8, for bottom temperature 36°.4. In 1874 the surface average for December at Norfolk was 43°, or 6°.4 higher than in 1876, the year from which our tables of observations are made up. The average for Norfolk surface temperature in November was, in 1876, 53°.4, in 1874, 55°.1 or 1°.7 higher. It is quite probable that in 1874 the water of the Lower Potomac did not become colder than 50° until December.

At Wilmington the monthly means of bottom temperature in 1876 and 1877 were for December, 43°.1, January, 43°, February, 48°.5; in 1874 and 1875, December, 48°.1, January, 43°.8, February, 45°.5. December, 1876, was unusually cold, the mean temperature of the air being 46°.3, against 59°.1 for the same month in 1874. January and February of 1874 were relatively cold, their air temperature being 48°.1 and 53°.1, against 57°.1 and 52°.5 in 1876. The surface quarter-month averages for the last half of February, 1877, are 49°.1, 50°.5; for the first half of March, 1876, 52°.6, 57°; for late November and early December, 1876, 57°.1, 53°6, 46°.6, 45°.3.

No observations have been made upon the movements of the menhaden at Wilmington. At Beaufort, 30 miles farther north, they appear to be absent during the winter.

It is much to be regretted that there are no temperature observations from Cape Hatteras. The relations of this locality to the Gulf Stream are peculiar, and corresponding peculiarities in the temperatures no doubt exist. The hundred fathom curve is distant about 40 miles from the point of the cape, and the average summer limits of the Gulf Stream, as laid down upon the British Admiralty charts, extend nearly into this curve. The observations made at Wilmington, situated as it is in a bend of the coast, at least 100 miles from the summer limits of the Gulf Stream, and at the mouth of a river which rises 200 miles away in the elevated central portion of North Carolina, can hardly be taken as criteria of the temperatures of Cape Hatteras. This is still more unfortunate from the fact that the movements of the menhaden, bluefish, "sea-trout," and other warm-water species are very peculiar at this point. It will be strange if the monthly mean of water temperature for Cape Hatteras in December, and perhaps January, does not prove to be more than 50°.

Savannah is at least 120 miles from the Gulf Stream, and its means for December and January, 1876-1877, as well as those of Charleston, are below 50°. Charleston water appears to be uniformly warmest. In

1874, December in Charleston averaged $48^{\circ}.8$; in 1875, January averaged $50^{\circ}.2$.

The movements of the menhaden in this region have not been observed, but since in the north it is not more hardy than the shad, and since the shad do not venture into the Georgia and Carolina rivers in December, it is safe to predict that the habits of the menhaden are similar.

Jacksonville, Fla., is the only point on the east coast from which there are observations showing a temperature uniformly above 51° , and here the menhaden remain throughout the winter.

Maximum limits of temperature.—On the coast of Eastern Maine we are told that the menhaden schools keep passing to the eastward until about the middle of July, when their impetus is apparently checked and their movements for thirty or forty days seem to be local only. During this period the temperature at Portland ranges from 60° to 70° , this being the height of mid-summer. The monthly means for July and August, 1876, were $66^{\circ}.7$ and $63^{\circ}.9$. The same months at New London are placed at 73° and $73^{\circ}.3$; at Norfolk, $84^{\circ}.1$ and $78^{\circ}.3$. Wilmington, Charleston, and Savannah do not range much above Norfolk; June, July, and August at Jacksonville average above 85° , and we have no satisfactory evidence that the menhaden are seen there in mid-summer. At Key West the lowest monthly mean is December, at $66^{\circ}.4$, in an unusually cold winter.

Preferred range of temperature.—These facts appear to indicate that under ordinary circumstances the menhaden prefers a temperature of 60° to 70° Fahrenheit. When the rising temperature of spring has passed the limit of 50° to 51° the fish are certain to appear, and when the falling temperature of autumn reaches that point their departure is equally sure, though a few individuals may linger in waters not congenial to them. The opposite limit seems to be marked by the line of 80° or perhaps 75° . An easterly or northerly wind, lowering temporarily the surface temperature, causes the schools to sink below the surface, as is shown in paragraph 95. The chill of night also drives them down.

These conclusions are not to be regarded as final. The movements of the fish about Cape Hatteras are very puzzling and need to be interpreted by a series of careful temperature observations.

It is a well-established fact that the summer of 1877 was not so warm as that of the preceding year. It is also known that the catch of menhaden in Maine for that year was much smaller than in 1876, when it was unusually large. There may be a connection between these circumstances, though the observations of water temperatures at my disposal are not sufficient to warrant decided generalization. The means for the summer months of 1876 were, at Eastport, $45^{\circ}.5$; at Portland, $57^{\circ}.9$; at Wood's Holl, $70^{\circ}.4$; at New London, 68° ; at Norfolk, $78^{\circ}.7$. The corresponding means for 1877 were, at Eastport, $42^{\circ}.8$; Portland, $57^{\circ}.6$; Wood's Holl, $67^{\circ}.7$; New London, $66^{\circ}.9$; and Norfolk, $77^{\circ}.2$. The summer of

1877 was then colder than that of 1876 by $2^{\circ}.7$ at Eastport; by $0^{\circ}.3$ at Portland; by $2^{\circ}.7$ at Wood's Holl; by $1^{\circ}.1$ at New London; and by $1^{\circ}.5$ at Norfolk. July, 1877, was colder than July, 1876, at Eastport by $2^{\circ}.8$; at Portland by $2^{\circ}.2$; at Wood's Holl by $5^{\circ}.9$; at New London by $1^{\circ}.2$. August, 1877, was colder than August, 1876, at Eastport by $0^{\circ}.3$; at Portland by $0^{\circ}.6$; at Wood's Holl by $0^{\circ}.9$; at New London by $3^{\circ}.1$. September and October of 1877 were warmer than the corresponding months of 1876 at Portland, and this agrees with the fact that the catch of menhaden in Maine was entirely made in the fall months.

General discussion as to the winter habits of summer fishes.

86. The relations of the temperature of the water to the movements of the menhaden schools having been studied, a new question is at once suggested. When the schools disappear from our coast, driven by falling temperature, where do they go? The answer must be in the form of a theory, for no one has seen them during their winter absence; at least no one has been able to identify the New England and Middle States fishes after their departure in the autumn. It is evident that there are but three courses open to our coast fishes when it becomes necessary for them to leave inshore—

(1.) They may swim out to sea until they find a stratum of water corresponding in temperature to that frequented by them during their summer sojourn on our coast.

(2.) They may swim southward until they find water of the required warmth.

(3.) They may descend into the abyssal depths of the ocean, there to remain for a season in partial or total torpidity.

The last of these theories is the least plausible, from the fact that it necessitates the greatest change in habits. The susceptibility of the menhaden to slight changes of temperature has been pointed out. Hibernation in the oceanic depths involves a change to a temperature 10° to 25° colder than that preferred by them in summer, as well as other important changes in respect to specific gravity and pressure.

The theory of hibernation discussed with special reference to the habits of the mackerel.

87. The hibernation theory is a favorite one with the fishermen of the British Provinces, and has recently received strong support from Professor Hind, in his treatise on the fisheries of North America. His arguments refer to the mackerel, although the scup, tautog, and herring are included by implication. He refers to the appearance of the mackerel "with scales on their eyes and blind," and suggests that the winter sleep of fishes is probably much more general than is usually supposed. He takes the position that there are only two alternatives possibly open to fishes which cannot live in cold water. They must migrate south or

hibernate. His arguments naturally fall into two categories—those against migration and those in favor of hibernation. Those in favor of hibernation may be summed up as (1) the testimony of fishermen and travelers; (2) the quoted opinions of theorists; (3) the alleged hibernations of other fishes; and (4) peculiarities in early and late fish.

(1.) The statements of one M. Pleville le Peley, “an eye-witness,” are quoted both from Lacepede and H. de la Blanchere. M. le Peley gravely states that he had observed about the coasts of Hudson’s Bay “the mud at the bottom of the small clear hollows incrustated with ice round their coasts, entirely bristled over by the tails of mackerel imbedded in it nearly three parts of their length,”* and again “affirms having seen in the middle of winter, in deep muddy bottoms, myriads of mackerel, packed close one against the other, with one-half of the body plunged in the mud, where they remained during the winter. As soon as spring came they aroused themselves from their torpor, and appeared always on the same day on the same coast at the surface of the sea, and repaired to favorable spots to spawn.”† The absurdity of these statements renders it unnecessary to criticise them. The other testimony is less definite. A Newfoundland fisherman remembers to have heard his father say that forty years before “he had often seen mackerel in White Bay come on shore like squid, with scales on their eyes and blind, about Christmas.”‡ And, again, a statement quoted from the Rev. John Ambrose, that “mackerel have been brought up from the muddy bottoms of some of our outer coves by persons spearing for eels through the ice,”§ which statement is not supported by the personal evidence of Mr. Ambrose, being merely a hearsay story. And this is all.

Professor Hind, in Part II of the same work|| remarks confidently: “That the mackerel spends the winter months in a torpid condition near to the locality where the schools first show themselves on the coast has already been adverted to,” and again refers to “the fact, already noticed, that it is taken in winter from muddy bottoms.” I submit that no such fact has been established and that Professor Hind’s generalizations are without foundation. There is much better evidence to prove that swallows hibernate in the mud of ponds, a theory which has had numerous advocates since the time of Gilbert White, of Selborne.

(2.) Professor Hind first quotes from “*La Pêche et Les Poissons*” of M. H. de la Blanchere. The statement, printed as it is in a single paragraph instead of two and not given in full, conveys the impression that M. de la Blanchere indorses the views of Pleville le Peley, already quoted. On the contrary, he states explicitly: “The question of the annual and

* Hind, *op. cit.*, Part II, p. 10, note.

† Part I, p. 78.

‡ Part I, p. 78.

§ Observations on the Fishing Grounds and Fish of St. Margaret’s Bay, N. S., by Rev. John Ambrose. <Proceedings and Transactions of the Nova Scotian Institute of Natural Sciences, 1866-’67, quoted by Hind, *op. cit.*, Part I, p. 79.

|| P. 10.

regular appearance and disappearance of this fish is still unsolved." He then proceeds to contrast with M. le Peley's views those of Duhamel de Monceau, Anderson and others, who represented that the mackerel pass the winter in the northern seas, and in spring, beginning their migrations, pass southward visiting first Iceland, then Jutland, then Scotland, and Ireland, and the coasts of Continental Europe, in autumn assembling together for a return to the polar regions. Then he quotes Pleville le Peley, and remarks: "This theory associates the mackerel with many other sedentary fishes which pass the winter at the bottom of the sea, stupefied by the cold into a kind of lethargy, and would serve to explain why, in October, young mackerel of 10 and 15 millimeters are taken, why in winter others of larger size are taken, not with a line, but with nets, which entangle those which had not already buried themselves in the mud or the sand."*

Another quotation is made† from Shaw's "General Zoology, or Systematic Natural History," published in 1803. Professor Hind says that "the four disputed points in relation to the natural history of this fish are there asserted, namely, its local habits, its torpidity during hibernation, the film over the eye, and the fact of its being partly imbedded in the soft mud or sand during its winter sleep."

I admit that Shaw asserts the presence of a film over the eye. He does not, however, even give the theory of hibernation his personal indorsement, but remarking that the long migration of the mackerel and herring seems at present to be called in question, continues, "It is thought more probable that the shoals which appear in such abundance round the more temperate European coasts, in reality reside during the winter at no very great distance, immersing themselves in the soft bottom, and remaining in a state of torpidity, from which they are awakened by the warmth of the returning spring, and gradually recover their former activity."

Even if Shaw could fairly be quoted as a supporter of this theory, his opinion is of little value. He was not a naturalist, but a book-maker, and his compilations are acknowledged to be inaccurate.‡

The opinions of Dr. Bernard Gilpin and the Rev. John Ambrose, two excellent Nova Scotian observers, are quoted,§ though with no apparent reason, for the latter remarks only that "it is the opinion of some" that the third run of mackerel, which takes place at St. Margaret's Bay about the first of August, are not returning from the Gulf of Saint Lawrence, but from sea, and "it may be that a portion of the immense schools passing eastwardly in the spring strike off to some favorite bank

* Nouveau Dictionnaire Général des Peches, &c., par H. de la Blanchere. Paris, 1868, p. 183, article *Maquerreau*.

† Hind, *op. cit.*, Part II, p. 10.

‡ See a criticism upon Shaw's General Zoology in Gill's Arrangement of the Families of Fishes, &c., 1872, pp. 40, 41.

§ Part I, p. 79.

outside to deposit the spawn. Or there may be a sort that never go as far east or west as the others, but winter along our shores," &c.; while Dr. Gilpin expressly remarks that though the *asserted torpidity and blindness* favor the idea of hibernation, he does not think that we have yet sufficient proof to assert them as facts.

The authorities quoted in support of the hibernation theory do not in fact support it, and the testimony cited by Professor Hind is merely tradition and popular opinion, some obtained directly, the remainder at second-hand.

(3.) Still another set of arguments is based upon the supposed hibernating habits of other species of fishes. Professor Hind remarks: "In seas which are not ice-encumbered the winter torpidity (of the mackerel) may be of very short duration; in ice-encumbered seas it may extend over several months. In this particular the mackerel resembles the sturgeon of the Caspian Sea, whose torpidity during winter is well known, and this winter sleep is not confined to these fish, but is probably much more general than is usually supposed." *

Here we have a definite statement. The mackerel hibernate, and the winter sleep is not confined to the mackerel.

The only hibernation which is definitely known to occur among fishes takes place in the fresh-water lakes and streams of cold regions. The fish are driven by cold into the deeper waters, and there remain in a state of torpor proportionate in degree to the amount of cold which they experience. They may even be frozen up in the midst of a mass of ice and recover their vitality when the ice is melted. †

In warm regions an analogous phenomenon takes place which has been called *æstivation*. When the lakes and streams are dried up by the heat the fish seek refuge in the deepest pools, and when these too are dry they bury themselves in the mud at the bottom and remain torpid until the rainy season refills the reservoirs and revives them.

Fishes in the extreme north doubtless undergo similar experiences, though I am not aware that any record of such a phenomenon has ever been published.

Hibernation and *æstivation* do not appear to be in any case voluntary acts. The fish do not become torpid of their own volition. They avoid it as long as they can, and only succumb when they are deprived of means of escape. They never become torpid when there are greater depths to which they can retreat. ‡

* Part II, p. 11.

† Mr. Milner had a mud-minnow (*Umbra limi*) which was frozen in solid ice in the middle of an aquarium globe three or four times, and each time recovered its vitality upon thawing out.

‡ "A curious phenomenon in Indian fresh waters, and one which has never been satisfactorily explained, is the sudden appearance of healthy adult fishes after a heavy fall of rain, and in localities which for months previously had been dry. When pieces of water inhabited by fish yearly dry up, what becomes of them? On January 18, 1869, when examining this question, I was taken to a tank of perhaps an acre in extent, but

(4.) Professor Hind lays much stress upon the presence of a "film" over the eyes of the spring and autumn mackerel and upon their alleged capture in winter in the waters of the Dominion, and also quotes arguments for hibernation based upon the resemblance of the mackerel to the batrachians (which are known to be capable of hibernation) in color, and upon its resemblance to embryonic forms of other fishes which is supposed to "prove him low in the scale of intelligence."* To the latter it is needless to refer. The so-called "film" on the eye is not peculiar to the mackerel. Many fishes, such as the shad, the alewife, the menhaden, the bluefish, the mullet, the lake whitefish, and various cyprinoid fishes have a thick, rough membrane covering the anterior and posterior angles of the orbits narrowing the opening to the form of an ellipse with a vertical major axis. This possibly becomes somewhat more opaque in seasons of decreased activity. It

which was then almost dry, having only about four inches of water in its center, while its circumference was sufficiently dried to walk upon. The soil was a thick and consistent bluish clay, from which, and not nearer than thirty paces to the water, five live fish were extracted from at least two feet below the surface of the mud. They consisted of two of *Ophiocephalus punctatus* and three of the *Rhynchobdella aculeata*. All were very lively and not in the slightest degree torpid. They were covered over with a thick adherent slime. Among the specimens of fish in the Calcutta museum is one of the *Amphipnous cuckia*, which was dug up some feet below the surface of the mud when sinking the foundation for a bridge. If when the water failed fish invariably died, the tank would be depopulated the succeeding year unless a fresh supply was obtained from some other source, while the distance from other pieces of water at which they reappear excludes, in many instances, the possibility of migration, which must always, to a certain extent, be regulated by distance, time, and other local circumstances. Some species, especially "compound breathers," are unable to live in liquid mud, which they cannot employ for purposes of aquatic respiration.

"The practical question is, whether, when food and water fail, some fish do not aestivate until the return of a more favorable season. Natives of India assert that they do thus become torpid in the mud. As the water in tanks becomes low, the fishes congregate together in holes and places in which some still remains, where they may be frequently seen in numbers huddled together with only sufficient water to cover their dorsal fins.

"If disturbed they dive down into the thick mud, so that a net is often found ineffectual to take them. The plan employed to capture them is for the fisherman to leave the net in the water, and to walk about in the surrounding thick mud; in time they come to the surface to breathe, and fall an easy prey.

"As the water gradually evaporates, the fishes become more and more sluggish, and finally there is every reason to believe that some at least bury themselves in the soft mud, and in a state of torpidity await the return of the yearly rains. In Ceylon, Mr. Whiting, the chief officer of the western province, informed Sir Emerson Tennent that he had accidentally been twice present when the villagers had been engaged in digging up fish. The ground was firm and hard, and "as the men flung out lumps of it with a spade, they fell to pieces, disclosing fish from 9 to 12 inches long, which were full-grown and healthy, and jumped on the bank when exposed to light. Many other animals which possess a higher vitality than fish aestivate during the hot months, as *Batrachians*, the *Emys*, the *Lepidosiren annectens*, and some of the *crocodiles*. Mollusks and land-snails are commonly found in this state during the hot and dry months. (Day's Fresh-water Fish of India, p. 28.)

* Part I, p. 79.

never has been observed to cover the whole eye. Until the fact has been established that "a skin forms over the eye in winter" it is quite unnecessary to propose the theory that such a skin "is probably designed to protect that organ from the attacks of the numerous parasitical crustaceans and leeches which infest the external portions of the bodies of fishes, and are also found internally, as in the gills of cod-fish" *.

Criticism of the argument based upon the presence of mackerel in northern waters late in the season.

A number of instances are cited to prove that the mackerel schools remain on the coast of the Dominion throughout the winter season. If this can be well established it is a very strong argument in favor of hibernation. Let us analyze the testimony.

Dr. Gilpin is quoted to the effect that during some seasons they linger on the Nova Scotian coast until December, and allusion is made to a mackerel obtained by him at Halifax, October 27, 1875.†

Mr. John Rice remembers that his father used often to speak of mackerel "coming on shore like squid with scales on their eyes and blind about Christmas," about 40 years ago.‡

Mr. Jabez Tilley states that they have been taken in November in Trinity Bay.

Professor Hind also states that they are to be found on the whole coast from Quirpon to Cape Spear during November and December. He gives no authority for this statement, and it is to be inferred that it is founded upon personal observation.

Then there is the vague statement of Mr. Ambrose, already quoted, that mackerel have been speared on muddy bottoms under the ice.

Now this testimony does not, by any means, tend to prove that the mackerel remain near the coast in winter.

In the first place there is no satisfactory proof of their occurrence later than October 25, since that is the only evidence fortified by a memorandum of date, and the memories of fishermen are not more certain than those of other men.

In the second place it is not impossible that mackerel linger in these waters until November or even December in the case of a very warm autumn. The temperature necessary for the menhaden cannot be many degrees below 50°, while the mackerel appears to endure a temperature of 41° or less. Menhaden linger in Maine waters till November and in Massachusetts Bay and the Vineyard Sound till December.

Finally, the undoubted capture of many individuals in winter on the coast of Newfoundland would by no means prove that the great schools were there throughout the season. Disabled, blind, or diseased individ-

* Hind, *op. cit.*, Part II, p. 11.

† Part I, p. 79.

‡ Part I, p. 78.

uals would naturally be unable to accompany the departing schools. Such fish would naturally grovel on the bottom in a helpless state and might easily become impaled on the eel-spears, or might be thrown on shore by the waves, as the Newfoundland fishermen relate. Even healthy fishes might occasionally be accidentally detained. Mr. Peter Sinclair a well-known fisherman of Gloucester, stated to Professor Baird that some years ago a school of mackerel were detained all winter in a small river in Nova Scotia, and were speared out of the mud. This is doubtless hearsay testimony and is given for what it is worth. I do not doubt that there have been individual cases of this kind, but I maintain that no generalization should be founded upon them.

The theory of extended migration discussed with reference to the habits of the mackerel.

88. The preceding paragraph is devoted to the refutation of the idea that sea-fish hibernate. This is regarded as the least probable of the three hypotheses stated in paragraph 85. In paragraph 84 it is stated that the sea-herring and many other fishes have two kinds of migrations: one bathic, or from and toward the surface; the other littoral, or coastwise. Now, in some species the former is most extended; in others, the latter. The anadromous species very probably strike directly out to sea without coasting to any great degree, while others, of which the mackerel is a fair type, undoubtedly make extensive coastwise migrations, though their bathic migrations may, without any inconsistency, be quite as great as those of the species which range less.

Upon this point I cannot do better than to quote from a manuscript letter from Professor Baird to the Hon. Hamilton Fish, Secretary of State, dated July 21, 1873. Having expressed the views concerning the migration of the herring and shad already quoted in paragraph 84, he continues:

"The fish of the mackerel family form a marked exception to this rule. While the herring and shad generally swim low in the water, their presence being seldom indicated at the surface, the mackerel swim near the surface sometimes far out to sea, and their movements can be readily followed. The North American species consist of fish which as certainly, for the most part at least, have a migration along our coast northward in spring and south in autumn, as that of the ordinary pleasure-seekers, and their habit of schooling on the surface of the water enables us to determine this fact with great precision. * * * Whatever may be the theories of others on the subject, the American mackerel-fisher knows perfectly well that in the spring he will find the schools of mackerel off Cape Henry, and that he can follow them northward day by day as they move in countless myriads on to the coast of Maine and Nova Scotia."

It is difficult to estimate to what extent the advocates of the hibernation theory have been influenced by patriotic motives in their efforts

to prove that the mackerel remain in the waters of the Dominion of Canada throughout the entire year. It is certain that all recent treatises on ichthyology by Canadian writers have appeared in the form of campaign documents apparently intended to influence the decisions of diplomatic commissions.

I am by no means prepared to maintain that mackerel do not pass the winter in the American domain of Her Imperial Majesty. It seems important, however, that the subject of the migration of fishes should be restored to its proper position as a question of abstract scientific importance. Let us glance at the arguments of Mr. Whitcher and Professor Hind against what the former is pleased to style the "American theory."

In the report of the Minister of Marine and Fisheries for the year ending the 30th of June, 1871, Mr. W. F. Whitcher, Commissioner of Fisheries, published a paper entitled "American theory regarding the migration of the mackerel refuted".*

Mr. Whitcher opens his letter by claiming that the theory of north and south migration was invented solely in support of a claim advanced by citizens of the United States to participate in the Canadian inshore fisheries. "This ingenious but traditional theory of annual migration having gained local credence among some of the Nova Scotian fishermen engaged in United States fishing-vessels, has been sagaciously indorsed and circulated by American authors." He also refers to evidence "supposed to have been procured among the fishing population of the New England States."

I need only say that these claims are unjust, and that the theory of the annual north and south migration of the mackerel is time-honored, and was held conscientiously by ichthyologists of the United States and the provinces long before the question of fishery treaties assumed its present aspect. It is manifestly unfair to state that, while the theories which prevailed respecting the habits of herring and mackerel were formerly similar, that "in the former case it is probable that traditionary and imperfect information formed the basis of error, while in the latter instance it is most probably founded on misinformation dictated by sectional interests." Mr. Whitcher's own paper upon migration is the only one of American origin in which I have seen scientific method sacrificed to partisan spirit.

Having read Mr. Whitcher's introduction, one might readily predict what sort of an argument he will wrench out of the statements of "such disinterested authorities as may be readily quoted." First he gives extracts from Mitchell and the Edinburgh Encyclopædia regarding the habits of the herring. Granting all that is claimed about the herring, without reference to the liability of these authorities, what do we find? Merely a begging of the question. The habits of the herring and the mackerel are not known to be the same. In many particulars they are

* Pages 186-189.

diametrically different, for the former loves cold water, the latter warm water.

Various provincial writers are now quoted; Mr. Perley, who says that "naturalists now tell us" and "it is now considered settled" that the mackerel is not migratory, but draws off into deep water at the approach of winter, and Mr. Knight and Mr. Fortin, though the reason for these quotations is not apparent, since no reference to the winter habits of the fish can be found therein. He does not refer to the writings of Mr. Ambrose and Mr. Johnson, Canadian writers, who advocate the migratory theory.

Yarrell and Couch are next quoted, though neither of them has ventured to give a decided opinion.

Finally, we have a paragraph compiled from five French encyclopedias, good and bad, no means being afforded of distinguishing the opinions of Cuvier from those of Chenu's literary staff.

Mr. Whitcher's conclusion is this: that "it is clearly neither necessary nor accurate that mackerel should perform the migrations ascribed to them by American writers."

The migrations of the mackerel are neither proved nor disproved by special pleadings of this description. The spirit of Professor Hind's writings is very different. He writes from the stand-point of an investigator, and his book is an important contribution to our knowledge of the habits of fishes in relation to temperature and currents. I feel obliged, however, to call attention to a very serious flaw in his chief argument against the annual migration of the mackerel.

In the chapter on the "Relation of the Supposed Migratory Movements of Mackerel to Isothermal Lines,"* it is claimed that a migration to the north in the spring "presupposes the movements of bodies of the same great schools of mackerel which are alleged to pass Massachusetts Bay from the waters of the coasts of Virginia and New Jersey, not only through from ten to twelve degrees of latitude, but it assumes that they are able to cross in the early summer, and frequently before spawning, numerous isothermal lines in descending order."

He then refers to the article upon the Gulf Stream in Petermann's "Mittheilungen" for 1870, in which the marine isothermals for the different months are shown by means of a chart. A table is given showing the isothermals for July. That of 68° would touch the coast at Delaware Bay, that of $63^{\circ}.5$ at Long Island, that of 59° at Boston, that of $54^{\circ}.5$ at Cape Sable, Nova Scotia, that of 50° at Cape Race, and that of $45^{\circ}.5$ at the Straits of Belle Isle.

From this he concludes that a "a school of fish, moving rapidly from Delaware Bay to the Straits of Belle Isle, would pass in July from a mean temperature of 68° to a mean temperature of 45° , a difference of more than 22° Fahrenheit.

This theory would be very satisfactory if it could be admitted that the

*Hind, *op. cit.*, part ii, pp. 15-17.

isothermals for July indicate the actual temperature of the sea from day to day. In reality the marine isothermals are constantly varying, and, in this respect are different from those printed upon a chart. A glance at the tables in Appendix F, and the conclusions deduced from them in regard to the menhaden (paragraph 85), will show that schools of fish do not find it necessary to force their way through walls of sea temperature, but that their movements from south to north are exactly correlated with the seasonal rise of temperature. As soon as the water at a given point reaches the necessary temperature, which for the mackerel on our own coast appears to be as much as 45°, the fish make their appearance, and with the advance of the season they appear farther and farther to the north. Mackerel do not appear on the coast of Maine until the water is as warm as it was off Cape Hatteras at the time of their first arrival. This is the case whether we suppose their general movement to be parallel with or vertical to the coast line.

I have entered the discussion of this question not with any idea of attempting to prove that mackerel migrate south from the Gulf of St. Lawrence, but to show that a comparatively rapid northward movement in May and June does not necessitate a "sudden plunging from high to low zones of temperature."

Arguments against extended migrations of menhaden.

89. There is no satisfactory evidence that the menhaden pursue extended migrations north and south. The same evidence which tends to show that the shad, salmon, and alewife do not follow this course will apply, with modifications, to the menhaden.

The menhaden schools at different points along the coast appear to have individual peculiarities, corresponding to those of the shad in the different rivers. A Maine menhaden may easily be distinguished from a Long Island menhaden, a Chesapeake or a Florida one, by certain indescribable characters, easy to perceive but difficult to define. The presence of the crustacean parasite in the mouths of southern menhaden, and its constant absence from those of the north is a very strong argument in favor of local limitation in the range of menhaden schools.

That the same schools of menhaden return year after year to the same feeding grounds is rendered very probable by the statements of Mr. Miles in paragraph 72.

The schools in the southern waters do not receive any apparent increment at the time of desertion of the north coast, nor are the southern waters deserted at the time of abundance in the north. There is, however, a limited north and south migration. The Maine schools on their departure in the fall appear to follow the southward trend of the coast until they strike the hook of Cape Cod, where they are detained for some days; they then round the cape and are again detained by the hook of Montauk Point. They first strike the shore at Point Judith and are

turned over into Peconic Bay by the line of islands stretching across the eastern end of Long Island Sound.

In this same way the Chesapeake schools are said to be detained for some days by the projection of Cape Henry.

The hypothesis of oceanic sojourn of the menhaden.

90. The questions of hibernation and extended migration having been considered, it only remains to discuss the third alternative, that of the possibility of sojourn in the warm strata of the open ocean.

In plate XII is given diagram sections of the North Atlantic Ocean between New York and Bermuda, showing the soundings and isothermal lines obtained in Her Majesty's ship "Challenger", April 24 to May 8, 1873. The vertical scale is necessarily enormously exaggerated, but the diagram shows the presence of strata under the Gulf Stream, and between it and the American coast, the temperature of which exactly meets the requirements of the menhaden. At a depth of 50 to 100 fathoms there is a shoreward extension of the warm stratum of 50° to 55° which extends inward one hundred and twenty miles. There are no means of determining the corresponding isothermal lines on the coast of North Carolina, but an extension of much less degree would approach very near the shore in that region. The diagram represents the condition of the sea temperature near New York at the very period when the menhaden are approaching the coast in April, and a similar relation not improbably exists in November, at the time of their departure. The schools of fish swimming out to sea when the shore waters become too cold for them, and driven below the surface by the winds of November, would naturally strike these temperate strata, and being kept from descending deeper by the uniform coldness of the waters below, as well as by the increasing pressure, and their efforts to approach the shores being also opposed by a temperature barrier, they would remain in the temperate strata until they were enabled by the warmth of spring to regain their feeding grounds near the shores.

No authorities can be quoted in support of this hypothesis, but, in the case of the menhaden at least, it appears to explain more of the difficult questions in relation to periodical movements than that of hibernation or that of extended migration.

(1.) It presupposes less sudden changes of temperature than that of hibernation. It has been shown that hibernation of fishes is never voluntary, but is a state of torpidity induced like that of æstivation by a change of temperature and surroundings which they have no power to avoid. Before entering upon hibernation or æstivation fishes retreat to the deepest water, and only become completely torpid when they are followed thither by the changed conditions of existence. In the fresh waters of temperate regions fishes do not become entirely torpid in cold weather, but are sufficiently active to be taken with hooks from under the ice. This is also the case in very deep waters in subpolar regions. The

kalleraglitz or American turbot (*Reinhardtius hippoglossoides*) is taken with hooks, in the dead of winter, under the floe ice of North Greenland at a depth of 300 fathoms; in South Greenland, on the oceanic banks, at 60 and 80 fathoms; and at Fortune Bay, Newfoundland, it is captured in the shore herring-seines at the same season.

So long as the menhaden can avoid the extremes of temperature which they so carefully avoid in the summer by seeking congenial warmth in the ocean strata under the Gulf Stream, need we suppose that they will plunge into the colder strata below?

(2.) It involves less radical changes than hibernation in the habits of the fishes. Some fishes, like the mud-minnow (*Umbra limi*) of the Eastern United States, are peculiarly adapted for life in the mud; others, such as the "compound breathers" (*Labyrinthici*) of India, are said to respire with ease with their heads covered by liquid mud. Such fishes, however, are totally different in organization from the free-swimming species of the open seas. All free swimmers are especially heedful to avoid contact with the bottom. This is especially so in the case of the herring family, of which the menhaden is a member. They are provided usually with deciduous scales, and never suffer themselves to come in contact with the bottom. If one of the herring or mackerel tribe is placed in an aquarium, it will be noticed that it keeps itself always free from the bottom. Other fishes in the same tank, such as the sea-bass, tautog, or king-fish, will be seen to rest on the bottom, and even to take refuge under the stones.

It is improbable that mackerel ever voluntarily sink into the mud of the ocean bottom; still more so in the case of the menhaden.

(3.) It accounts better than the other theories for the early appearance of the fish in the spring.

Admitting the possibility of a winter's sojourn in the mud, we are met by a difficulty when we try to account for the prompt appearance of the fishes in the spring. The deeper strata of the ocean are now known to preserve throughout the year the uniform temperature of 22° to 40°. The fish, once mummified in the depths of the ocean, would remain so forever, unless they possess powers unknown to exist in other animals.

On the other hand, if we suppose the fish to be swimming in the strata of mid-ocean, we know that they are in just the position to be susceptible to all the daily variations of temperature. Following, with the advance of the season, the inward curving of the Gulf Stream, the warm strata below it gradually approach the shore. The schools of fish are thus enabled gradually to draw nearer to the coast line, and when the strata of 50° to 55° in temperature touch the coast the menhaden are at hand.

(4.) It explains, as well as the hibernation theory and better than the migration theory, the peculiarity of the schools at different localities along the coast. This was discussed in paragraph 88.

(5.) It explains better than the other theories the appearance of the fish at the time of their arrival in the spring.

The menhaden appear to be bottom feeders. If they migrated coastwise to the south, they would there find feeding-grounds; if they sank to the bottom, they would there find food if they had sufficient vitality to resurrect themselves in the spring; if they passed the winter in the mid-ocean strata, they could obtain no food and would naturally become emaciated, the accumulated fat of the preceding summer being absorbed.

Rimbaud's classification criticised and a new one proposed.

91. Rimbaud's classification, which is a modification of one recognized in the markets of South France, is very suggestive, but it does not appear to me to be entirely applicable to the fishes of our coast, at least not in the way in which it has usually been adopted.

Rimbaud makes four divisions, viz:

I. Wandering fishes (*Poisson nomade*).

II. White fishes (*Poisson blanc*).

III. Bottom fishes (*Poisson de roche* or *Poisson de fond*).

IV. Alien or outside fishes (*Poisson forain*).

The distinction between Classes I and IV does not appear to be very clearly marked. In the Western Atlantic, some of the fishes making up Class IV belong to each of the other classes.

A more natural classification would be in three divisions, which might readily be correlated with the three kinds of migration mentioned in the preceding paragraph.

The first group would include the wandering fishes, the *Poisson nomade* of Rimbaud, whose migrations are entirely oceanic and confined to the surface zones. The second group would include the bottom fishes of restricted range, the *Poisson de fond* of Rimbaud, which move to and from the shore or the shallows, and which do not range. The third group would include the middle classes, those which take advantage of both methods of migration, and corresponds approximately to Rimbaud's second division. "White fishes" seems hardly an appropriate name: "coast fishes" would perhaps be more expressive.

Colonel Lyman, in his report "On the Limits of Artificial Culture, and the Possible Exhaustion of Sea-fisheries"* (p. 67), speaks of the first class as "the wandering or schooling fishes of the high seas." The term "schooling" is liable to mislead, for the "white fishes" also school. Among the wandering fishes he mentions only "the herring (*Clupea elongata*), mackerel (*Scomber vernalis*), menhaden (*Alosa menhaden*), cod (*Gadus morrhua*)," &c. The cod and herring most certainly are "white fishes," and the menhaden and mackerel are certainly not to be ranked with "those which appear on the coast only when 'migrating,' and then in vast but uncertain troops" (p. 63).

* Report of the Commissioners of Fisheries (of Massachusetts) for the year ending January 1, 1870, pp. 58-67.

A provisional classification, by habits, of the fishes of our eastern coast might stand somewhat as follows :

I. *Wandering or surface fishes*.—These remain in our waters only for a short time, their movements being capricious or accidentally directed by the ocean currents, or else in search of food. They do not spawn on our coast, and their young are never seen in our waters.

The best-known examples are the sword-fish (*Xiphias gladius*), the spear-fish (*Tetrapturus albidus*), the bonito (*Pelamys sarda*), the tunny (*Oreynus thynnus*), the dwarf tunny (*Oreynus alliteratus*), the ceroes and Spanish mackerel (*Cybius maculatum*, *C. caballa*, and *C. regale*), the rudder-fishes (*Seriola zonata*, *Naucrates ductor*, and *Palinurichthys perciformis*), the dolphins (*Coryphæna*, two or three species), the remoras (*Echeneididæ*), the barracuda (*Sphyræna borealis*), the lady-fish (*Albula vulpes*), the tarpum (*Megalops thrissoides*), the oceanic sharks, such as *Galeocerdo tigrinus*, and the numerous waifs from the West Indian fauna.

Of these only the sword-fish, bonito, and the ceroes and Spanish mackerel are of economic importance at present.

II. *Local or bottom fishes*.—These remain in our waters throughout the year, their movements being chiefly to and from the shores, though many of the species move for long distances up and down the coast. They prefer a somewhat uniform temperature, which they secure by going into the shallows in summer and deeps in winter in the northern districts of their distribution, while in their southern districts of distribution these movements are reversed. They spawn on our coast, usually in shallow water and during their shoreward sojourn.

The principal representatives of this group are the goose-fish (*Lophius piscatorius*), the flounders and flat fishes, the halibut (*Hippoglossus vulgaris*), of whose spawning habits little, however, is known, the lump-fish (*Cyclopterus lumpus*), and the two species of *Liparis*, the cod (*Gadus morrhua*), haddock (*Melanogrammus aeglefinus*), pollock (*Pollachius carbonarius*), and the hakes (*Phycis chuss* and *P. Americanus*), the gurnards and sculpins (*Prionotus*, sp. and *Cottus*, sp.), the rose-fishes (*Sebastes*, sp.), the tautog (*Tautoga onitis*), and the chogset (*Ctenolabrus chogset*), the skates, the rays, and the ground-sharks.

III. *The coast or ranging fishes*.—These are in our coast waters for a portion of the year, and when absent from them are supposed to retreat to the depths of the ocean. When near the shores their movements are a combination of those of the two previous classes, and they wander widely up and down the coast. They spawn upon our continental slope, some entering the rivers, some upon the inshore shallows, and some upon the off shore shoals, their young coming to the shores with the parents. They all are summer visitors in the northern districts of their distribution, though some, like the herring, only appear in New England in the winter.

The best-known examples of this group are, among the river-spawning or anadromous species, the salmon (*Salmo salar*), the shad (*Alosa sap-*

idissima), the alewife (*Pomolobus pseudoharengus*), the mallowacca (*Pomolobus mediocris*), and perhaps the striped bass (*Roccus lineatus*) and the smelt (*Osmerus mordax*); among the shore-spawning species, in the north, the capelin (*Mallotus villosus*), the launce (*Ammodytes lanceolatus*), and the herring (*Clupea harengus*); in the south, the scuppaug (*Stenotomus argyrops*), sheepshead (*Archosargus probatocephalus*), the sea-bass (*Centropristis atrarius*), the atherines (*Chirostoma notatum*), the mullet (*Mugil*, sp.), and the mackerel (*Scomber scombrus*); and among the off-shore spawners the pompano (*Trachynotus carolinus*), the squeteague (*Cynoscion carolinensis* and *C. regalis*), the menhaden (*Brevoortia tyrannus*), and probably the bluefish (*Pomatomus saltatrix*).

14.—THE MOVEMENTS OF THE SCHOOLS.

Habits of the schooling fish.

92. Making their appearance in our waters in the early spring, they rapidly increase in abundance until the sea appears to be alive with them. They delight to play in inlets and bays, such as Chesapeake Bay, Delaware Bay, Great Egg Harbor, Long Island, Block Island and the Vineyard sounds, Narragansett Bay, Buzzard's Bay, and the numerous narrow fiords on the coast of Maine. They seem particularly fond of shallow waters protected from the wind, in which, if not molested, they will remain throughout the season, drifting, with the tide, in and out of the shallow indentations of the shore and into the mouths of creeks and rivers. Brackish water attracts them, and they abound at the mouths of streams, especially on the Southern coast. They ascend the Saint John's River more than thirty miles, the Saint Mary's, the Neuse, the York, and Rappahannock. The Potomac they ascend nearly to Washington, a distance of sixty miles, and the Patuxent to Marlborough. In these rivers they come soon after the shad, and are so troublesome to the fishermen that their presence is easily determined.

I am not aware that this difficulty occurs in northern rivers. Professor Baird found them in the Hudson and its tributaries in the summer of 1854.*

They enter the Housatonic late in the summer. I am not aware that they ascend the Connecticut to any considerable distance from its mouth.†

They are found in the Mystic, Thames, and Providence Rivers, in the creeks on Cape Cod, in the mouth of the Merrimac River, and in some of the large rivers of Maine, such as the Kennebec and Penobscot.

Boardman and Atkins state that fish caught in the brackish water of the rivers are generally inferior as to fatness, "a fact indicating that they find there a poor feeding ground, and also that their stay there is long enough to affect their condition."

*Fishes of the New Jersey Coast, 1855, p. 34.

†This is perhaps due to the swift current of the river. Sea-going vessels fill their water-barrels at Essex, six miles from the bar.

Movements to and from the surface.

93. The arrival of the menhaden is announced by their appearance at the top of the water. They swim in immense schools, their heads close to the surface, packed side by side, and often tier above tier, almost as closely as sardines in a box. A gentle ripple, caused by the motion of the vertical fins, indicates the position of the school, and this may be seen at the distance of nearly a mile by the lookout at the masthead of a fishing-vessel, and is of great assistance to the seine-men in setting their nets. At the slightest alarm the school sinks toward the bottom, and in this way often escapes its pursuers. When sailing over a school of menhaden, swimming a short distance below the surface, one may see their glittering backs beneath, and the boat seems to be gliding over a floor inlaid with blocks of solid silver. At night they are phosphorescent and their backs glow like fire. The motions of the schools seem capricious, and without a definite purpose; at times they swim around and around in circles, at other times they sink or rise. Why they swim at the surface so conspicuous a prey to men, birds, and other fishes, is not known; it does not appear to be for the purpose of feeding; perhaps the fisherman is right when he declares that they are "playing." When they are pursued by other fish they fly in confusion like a flock of frightened sheep, and are often driven in great masses upon the shores.

The swimming habits of menhaden and mackerel.

94. An old mackerel-fisherman thus describes the difference in the habits of the schools of mackerel and menhaden:

"The pogies school differently from mackerel. The pogy slaps with his tail, and in moderate weather you can hear the sound of a school of them as first one, then another, strikes the water. The mackerel go along 'gilling'—that is, putting the sides of their heads out of the water as they swim. The pogies make a flapping sound, the mackerel a rushing sound. You can sometimes, in calm and foggy weather, hear schools of mackerel miles away."

Birds attracted by the schools.

95. They do not attract terns, as do the schools of predaceous fish, for they are too large to be an easy prey for those birds, and they are not in pursuit of crustaceans or smaller fish, which might also serve as food for the small birds. The bluefish and bonitos are attended by eager flocks of gulls and terns, which find a bountiful supply in the remnants of their voracious feasting, floating on the surface in their wake. The fish-hawk (*Pandion carolinensis*) often hovers over the schooling menhaden, and some of the larger gulls occasionally follow them in quest of a meal. About Cape Cod one of the gulls, perhaps *Larus argentatus*, is known as the "pogy-gull."

The influence of wind and weather.

96. On warm, calm, sunny days they may always be seen at the surface, but cold or rainy weather, and prevailing northerly or easterly winds, quickly cause them to disappear below the surface. In rough weather they are not so often seen, though schools of them frequently appear at the surface when the sea is too rough for the fishermen to set their nets.

Mr. Atkins and Mr. Dudley agree that the best days for menhaden-fishing is when the wind is northwesterly in the morning, dying out in the middle of the day, and then springing up again in the afternoon from the southwest, with a clear sky. At the change of the wind on such a day the menhaden come to the surface in large numbers.

A comparison of the influences of the weather upon the movements of the menhaden and its allied species, the herring, gives some curious results. The herring is a cold-water species. With the advance of summer it seeks the north, returning to our waters with the approach of cold weather. The menhaden prefers a temperature of 60° or more, the herring of 55° and less. When the menhaden desert the Gulf of Maine they are replaced by the herring. Cold weather drives the menhaden to the warmer strata below, while it brings the herring to the surface.

The observations of Herr von Freedon, of Hamburg, director of the German See Warte,* are important in this connection. Herr von Freedon made a thorough analysis of the log-books of the luggers engaged in the German herring fishery, and made an elaborate report to the Fishery Commission at Embden upon the influences which affect this fishery, especially the influence of winds and the temperatures of the sea. He has come to the conclusion that northwest winds are the best for large catches, and northerly winds better than southerly, westerly better than easterly; also that moderately strong winds, sufficient to ruffle the surface of the sea, are better than calm weather, and light winds almost as unfavorable as stiff breezes; a ruffling of the sea being, in his opinion, of considerable importance to success in fishing. For the temperatures of the sea, he regards a temperature from 53° to 57° as most favorable, the chances of success diminishing with higher or lower temperatures.

The conditions most favorable, then, for the appearance of herring at the surface are least so for menhaden, it being borne in mind that northwesterly and westerly winds on the east side of the Atlantic correspond to northeasterly and easterly winds upon the west side.

The movements of the herring as influenced by weather.

97. In the "Scotsman" of August 25, 1876 (quoted in "Nature"), is an interesting observation regarding the movements of the herring on the Scottish coast. The surface temperatures of the sea, as determined by the sea-thermometer furnished to the fishermen by the Scottish Meteorologi-

* See Report of the Commissioner of the Fishery Board of Scotland, 1875.

cal Society, is regarded to have been from 58° to 59° during the week ending August 19, but on the 21st, when the nets were shot, the temperature had fallen to 55° , and this was the first night the herring were caught. They were found low in the nets during the prevalence of warm weather between Northumberland and Peterhead.

"The Meteorological Society of Scotland have for two or three years had this capriciousness in the movements of the herring under special investigation, and in the past year the deep-sea thermometers provided to the society by the Marquis of Tweeddale, its president, for testing the temperature of the sea, were again sent out by the Fishery Board to their officers, and the temperature obtained at different periods of the herring fishery. Daily registers of the weather were kept and other particulars furnished to the society, both by the district fishery officers and by Samuel McDonald, esq., commander of the "Vigilant," fishery-cruiser. From the registers and the information thus supplied, the following conclusions have in the mean time been drawn by the committee of the society:

"From the observations of the catch of herrings and the temperature of the sea off the east coast of Scotland, during the two seasons of 1874 and 1875, it is seen (1) that the temperature of the sea from the middle of August to the close of the fishing season was continuously and considerably higher in 1875 than 1874; and (2) that the catch of herrings was continuously and considerably lower during 1875 than during the same period of 1874.

"Another result is this: If there be a district where, from any cause, the temperature of the sea is lower than in surrounding districts, in that district the catch of herrings is heavier; and conversely, if there be a district where, from any cause, the temperature of the sea is higher than in surrounding districts, in that district the catch of herrings is less. Among the causes which bring about a local increase or decrease of sea-temperature, the chief are clouded or clear skies in respective districts, according as these occur during the day or during the night. These local variations in the temperature of the sea in their bearings on the catch of herrings have been shown by the observations both of 1874 and 1875.

"Another important point is the relations of surface temperature to bottom temperature, and the relations of the deepest parts of the sea to the positions of the fishing grounds. It is found, for instance, that when the surface temperature is high—higher than lower down—the fish, if any be caught, strike the nets far down, in such a way as to lead to the supposition that a good deal of failure may often arise from the nets not going deep enough. The fish prefer, apparently, so far as the inquiry has gone, the lower to the higher temperature. The herring committee are most desirous of carrying out this line of inquiry into greater detail, if some of the fishermen could be induced to take the trouble of observing the temperature of the sea at the surface and also at the depth at which the fish strike the nets.

"The influence of thunder-storms was equally seen as in former years. If there is a thunder-storm of some magnitude extending over a large portion of Scotland, good takes may be made on that day; but on the following day few, if any, fish are caught over that part of the coast *unless at the extreme verge of a deep part of the sea*, as if the fish were retreating thither.

"Owing to the shortness of the time over which the inquiry has extended, the committee wish these results to be considered only as provisional. The results are, however, of the greatest value, not merely as indicating the lines of inquiry to be followed in further carrying on this large investigation, but also as indicating, in some cases not obscurely, the nature of the results which will ultimately be established—results which, since they lead directly to a knowledge of the localization of the herring, will serve as a guide to the fishermen where to set their nets with the highest probability of success."

The influence of the tides on the menhaden.

98. There has been no decided relation observed between the movements of the schools and of the tide.

Following the coast in its northward trend they crowd into the bays and sounds, and breaking up into smaller schools the detachments find their way into the shallows. In outside waters they do not appear to be affected by tides, and when they are migrating they seem independent of its influence. Mr. Dudley states that they often rise to the surface when the tide changes near the middle of the day. This is doubtless in waters near the shore, where the change of tide would be accompanied by some slight change of temperature. Mr. Simpson feels certain that more enter the inlets of North Carolina on the ebb than on the flood. It seems to be true, however, that throughout their halt during the summer, many schools drift lazily with the tide into the bays and creeks, coming in with the flood-tide, going out with the ebb-tide. In Southern waters they appear to hug the shore as closely as they can, and at high water thus gain access to waters too shallow for them at any other time.

15.—ALLEGED CHANGES IN HAUNTS AND HABITS.

The alleged changes of habit caused by the fisheries.

99. Many of the remarks in the preceding chapter are applicable to the menhaden only when they are left to enjoy their favorite haunts undisturbed. On the coast of Maine their habits are said, temporarily at least, to be greatly modified through the influence of man. They no longer hug the shores, but are found many miles out at sea, where they are followed by the fishing-vessels. The introduction of steamers into the fisheries is an evidence of this change of habit, and indeed the almost unanimous testimony of the Maine fishermen, from whom letters

have been received, is that the use of nets and seines tends to scare the fish farther out to sea. The purse-nets are set generally at a distance of from five to twenty-five miles from land.

Off Penobscot Bay menhaden are frequently caught by Brooklin fishermen outside of Isle au Haut and Great Duck Island.

According to Mr. W. H. Sargent the fish are much less numerous in the creeks, coves, inlets, and rivers, though outside no decrease is perceptible.

Capt. William S. Sartell, keeper of Pemaquid Point Light, writes: "The menhaden come regularly every summer into the bays, but the seining draws them off out of sight of land so that the fishermen here can't get bait to put on their hooks. They get some fish in their nets on Sundays when the seines are laid by."

Mr. Babson writes: "Since they have been taken in large quantities for their oil, they have gradually avoided the bays, creeks, harbors, and rivers to which they once resorted in immense numbers, and are now principally taken from one to ten miles from the shore. (Some of the fishermen maintain that since the advent of the bluefish, some twenty years ago, the pogies have sought deeper water for their own safety, while others maintain that the bluefish drive the pogies into shoal water; both statements are doubtless at times true.)"

Mr. Kenniston states that the fish are now farther off shore than in former years, and in this he is confirmed by Mr. Phillips, who states that they are taken better off shore where the seines cannot touch bottom. On the other hand, Mr. Washburne and Mr. Brightman are of the opinion that the use of the seine does not influence the movements of the fish.

Mr. Church, who has had much experience in the fisheries of Rhode Island, is very positive in his opinion. He writes: "The nets and seines do not scare the fish from the shore, for Narragansett Bay has been the theater of their greatest capture for forty years or more, and they have been more plenty than ever before known for the last ten years. I have seen a school of fish set at ten times in succession in deep water, and they would dive under the seine each time, but when they came to the surface they would not be ten feet from the seine, and they would lie still until we got ready to set, and when the seine was around them they would dive again. Fish will drive menhaden but man never does, except by use of powder; the menhaden are sensitive to a jar, such as is caused by striking the deck of a vessel with an ax. Even so slight a jar as the dropping of an oar or the careless slat of a rung on the gunwale has sent a school of fish off at top speed." Mr. Dudley confirms this. Steamers must carry low-pressure engines and run as noiselessly as possible.

Fishermen on Long Island Sound and about its eastern entrance seem to be divided in opinion. Messrs. Sisson, Havens, B. Lillingston, Washington, Crandall, and Dodge incline to think that fishing with nets

drives the fish away, while Messrs. Whaley, Potter, Wilcox, Beebe, Ingham, Miles, F. Lillingston, and Hawkins Brothers share the opposite belief. It should be noted in this connection that in Long Island Sound and vicinity purse seines worked off shore have almost superseded the haul-seines used twenty or thirty years ago, which were worked from row-boats and drawn up on the beaches. Does not this point to a change in the habits of the fish? In this district, where the fisheries are mostly prosecuted in waters more or less land-locked, the fish are not so apt to be driven out to sea as in Maine, where the fishing is prosecuted on an open coast. The timid fish may easily be crowded out into deep water by the vessels, which, working from the shore, usually approach them from that direction. If the fisheries of Maine were to be suspended for a short time the fish would doubtless return in full force to their former haunts. It appears from the statement of Mr. Sartell, already quoted, that they appear inshore in considerable numbers if the large seines are laid up for a single day. Mr. Simpson thinks that a school which is frightened away by nets returns to the same place in the course of two or three hours. South of Long Island, menhaden fisheries have not been carried on to such an extent as to exert any modifying influence upon the habits of the fish.

The opinion of Mr. Atkins.

100. There is room for difference of opinion on this subject. Boardman and Atkins do not accept this view, and after the thorough study they have made, their views are entitled to much respect. They remark:

"In general, it is safe to say that the surface movements of the menhaden are characterized by nothing so much as by capriciousness. They appear suddenly in the most unexpected spots, and, after a stay whose length nobody can foretell, all at once they disappear. One day they may be found at the mouth of the Kennebec, the next at Pemaquid, and the third all along the shore. Occasionally they reappear daily in the same spot for weeks at a time. Such was the case in the latter part of the season of 1874, over the sandy bottom off the Phippsburg beaches. Then it will sometimes happen that a whole season will pass without their appearance in bays where they have previously swarmed. Again, in some seasons they crowd the harbors and coves; in others they seem to avoid them altogether. For some years past they have so generally absented themselves from these places as to excite a good deal of speculation as to the cause."*

And again:

"Of the desertion of the harbors and coves there seems to be abundant testimony. An observer in Boothbay says: 'Menhaden can be driven out of small bays so that they will not come in.' 'Certain it is that they do not come into the bays as they used to.' In Bluehill we are

**Op. cit.*, p. 11.

told the same story. In Jonesport it is said, 'Pogies used to run into all the coves and creeks. Of late years they do not appear to frequent the shores as formerly.' Testimony of this sort might be multiplied; but it is unnecessary. The fact is notorious. During the past season (1874) they returned to some of their old haunts in great numbers, but have by no means resumed their former habit in this respect. Of this singular change of habit there are various explanations offered. According to some persons it is caused by the practice of seining; others lay it to the oil and decaying matter from the oil-factories. Neither of these causes appears sufficient to produce such a result. The desertion of the coves is observed in localities far removed from those where the alleged causes have operated. Perhaps, after all, the thing to be accounted for is why the menhaden ever crowded into small bays as they used to. Were they there in search of food, were they simply obeying blind instinct, or were they driven in by hordes of hungry foes outside? The latter supposition seems quite as probable as the others. We know that small fishes sometimes rush ashore to escape pursuit; we know that this happens with herring when flying from the pollock, and with menhaden when flying from the bluefish and horse-mackerel. The presence, outside, of a large number of predaceous foes, of whatever species, would be ample to drive the menhaden in. This might happen year after year; while with the cessation of the cause the result would cease too, and the menhaden would no longer crowd into the coves as before. If this view be correct, then the recent absence of the menhaden from the shores indicates an improvement in its chances of life, by the removal of its destroyers. Lack of information forbids an attempt to point out the species that have been most active in producing these movements of the menhaden; and indeed the theory itself is not proposed as one that has much of positive evidence in its favor, but just to show the possibility of accounting for the absence of the fish from shore on the hypothesis of the operation of causes purely natural, and not inimical, but positively favorable."

The opinion of Mr. Maddocks.

101. Still another view is advanced by Mr. Maddocks: "The menhaden, it is believed, does not of its own preference visit the coves and inner harbors, for its food seems to be less abundant in such localities, but to be driven into them by predaceous enemies. Upon the withdrawal of these, either in part or in full, the menhaden may reoccupy their former haunts at a remove from the shore, and thus disappear from inner waters."

I hardly think that the facts support this opinion. The habits of the fish when undisturbed, as they may be studied on the thousand miles or more of coast south of Cape Cod, are a safer guide than their habits on the much-seined coast of Maine.

102. Boardman and Atkins record some very interesting facts regarding

the change in the northern limits of the range of the menhaden within the past thirty years.

At Jonesport, Me., menhaden used to be very plenty. They were commonly caught in gill-nets two and one half fathoms deep, but it was practicable, almost any time, to get enough to go fishing with by spearing. They became scarce seven, eight, or ten years ago, and now very few are caught, although some come as far as this every year.*

At Lubec, thirty years ago or more, menhaden were so plenty during their short season (July and August) as to be a nuisance. They have not been plenty since 1840 or 1845, and now none are found east of Jonesport. They left suddenly, and since the date mentioned have been rarely seen. Mr. E. A. Davis, of Lubec, a man of long experience in the herring fishery, has not seen a single specimen for ten years. Mr. E. P. Gilles, also of large experience, in 1860, or thereabouts, got three hogsheads of them one afternoon tide, and since then has seen none.

At Pembroke, says Mr. Moses L. Wilder, "twenty years ago, and always before that, the menhaden used to come here every year in great numbers, filling every cove and creek; but for the past twenty years none whatever have been seen. Little use was ever made of them except for bait, and of that but little was needed here."†

There is also evidence to show that the waters of Nova Scotia and New Brunswick have of late years been entirely deserted by them.‡

E.—ABUNDANCE.

16.—ABUNDANCE IN THE PAST.

The testimony of early writers.

103. Of the abundance of menhaden in times gone by we can know very little, for they have never been considered an important species, and might easily escape the observation of writers. We infer that they were abundant the time of the Dutch colony on New York Island, two hundred years ago, from the name given to it by the New Netherlanders; in fact we have the statement, already quoted, of Dankers and Sluyter, who before 1679 saw in the bay of New York "schools of innumerable fish, and a sort like herring, called there *marlsbankers*." L'Hommedieu speaks of their abundance at the close of the last century.§

Professor Mitchill, writing in 1814, states: "They frequent the New York waters in prodigious numbers. From the high banks of Montock, I have seen acres of them purpling the waters of the Atlantic Ocean. The waters of Long Island Sound and its bay are often alive with schools of them."¶

* Statement of Z. D. Norton.

† Boardman & Atkins, *op. cit.*, p. 21.

‡ See below, paragraph 222.

§ Agricultural Transactions of New York, I, p. 65. See Appendix O.

¶ Transactions of the Literary and Philosophical Society of New York, 1815, I, p. 453.

In his deposition to Professor Baird, August 3, 1871, Capt. Nathanael Smith, an aged Newport fisherman, gave the following testimony: "Menhaden are decreasing too. In 1819 I saw a school of menhaden out at sea, when I was going to Portland, that was two miles wide and forty miles long. I sailed through them. We were out of sight of land. They appeared to be all heading southwest. There were no fish near them. I have seen a school on this coast three miles long. I think they spawn in April and May."*

Dr. DeKay, in his "Natural History of New York," says of this fish that, "although it is seldom eaten, as it is dry, without flavor, and full of bones, yet it is one of the most valuable fish found in our waters. They appear on the shores of Long Island about the beginning of June, in immense schools; and as they frequently swim with a part of the head above or near the surface of the water, they are readily seen and captured. They are commonly sold on the spot at the rate of \$2 the wagon-load, containing about 1,000 fish. The largest haul I remember to have heard of was through the surf at Bridgehampton, at the east end of the island. Eighty-four wagon-loads, or, in other words, 84,000, of these fish were taken at a single haul."

Mr. George H. Cook, writing in 1857, thus speaks of the abundance of menhaden on the coast of New Jersey:

"The moss-bunker (the *Alosa menhaden*, or *Clupea menhaden*), or, as it is sometimes called, bony-fish, menhaden, and other names, is an abundant fish in all the waters of this part of the State. It is frequently seen in immense shoals, fairly blackening the water for many miles. It is easily caught, and in large quantities at once. Mr. John Stikes, sen., of Beesley's Point, with his brother, some years since, caught, in a ninety-fathom net, thirty two-horse wagon-loads, at four hauls, taking fourteen of the loads at a single haul. Last summer, in a trip through the sounds from Beesley's Point to Cape Island, we passed through water filled with these fishes. Many of them swam so near the surface that their back fins projected above it; and the appearance of the water was entirely changed by the slight ripple they made in moving. They were most abundant then in the vicinity of Hereford inlet; but they are found near all the shores; and the only limit to the amount which can be taken is in the ability to take care of them when caught. Sixty wagon-loads, of at least 2,500, fish each, were taken at one haul in Raritan Bay this season."

17.—ABUNDANCE IN THE PRESENT.

On the coast of Maine.

104. Mr. W. H. Sargent considers the poggy the most numerous fish on the coast of Maine. Their capture affects their abundance in the coves and rivers and along the shore, though not outside. In 1873, Friend & Co.,

* Report of the Commissioner of Fish and Fisheries, 1871-'72, p. 21.

of Brooklin, took 25,000 barrels; Allen & Co., 15,000; others in the vicinity, 85,000. In 1874, about 15,000 were taken, the larger portion by Friend & Co. Between 1863 and 1868, some years 500,000 barrels have been taken. In 1877, Mr. Sargent estimates the total catch in his district at 100,000 pounds, or less than 400 barrels. Mr. J. C. Condon states that the fish are quite abundant about Belfast, Me.; 2,000 barrels were taken in the Belfast customs district in 1873; 3,000 in 1874. Seining does not appear to diminish their number. According to Mr. R. A. Friend, the pogies are much more numerous about Brooklin, Me., than any other fish; their numbers are not apparently diminished. About 14,000 barrels were taken in that vicinity in 1873, and 23,000 in 1874.

Mr. John Grant writes that, though pogies are more numerous about Matinicus Rock than any other fish except the herring, their numbers are decidedly diminished, probably on account of their wholesale capture.

Mrs. B. Humphrey states that at Manhagin Island these fish are more numerous than any other, but that seining has greatly affected their abundance.

Captain Coombs, of Esterbrook, who fishes for the Brightmans at Round Pond, Bristol, Me., recently caught with his seine, at one haul, 1,300 barrels of menhaden, and saved 1,179 barrels, made and valued as follows: Thirty tons scrap, at \$10 per ton, \$300; 3,650 gallons of oil, at 60 cents per gallon, \$2,190; total, \$2,490.*

At Sargentsville, Me., according to Mr. W. G. Sargent, 1,500 barrels of pogies were captured, in 1877, by Herrick & Bayard's boats. These were taken to the factories in the adjoining township of Brooklin.

Capt. Frank A. Chadwick, of New Harbor, Me., states that seven purse-seines are used in that vicinity, which catch an average of 15,000 barrels of menhaden annually, and a total amount of 125,000 barrels.

Mr. William P. Sprague, of North Isleborough, Me., writes that pogies are extremely abundant in that vicinity. A fleet of menhaden steamers, some twenty in number, has fished much here.

Mr. Lewis McDonald, of North Haven, Me., estimates the catch of menhaden for 1877 at 400 barrels.

The number of fish taken about Booth Bay and Bristol is given in the report of the Maine Oil and Guano Association, cited elsewhere. Mr. Sartell thinks that the fish are driven away by the seines. Mr. Kenniston and Mr. Brightman think that there is no perceptible diminution, as they continue by far the most numerous species. Mr. Washington Oliver thinks that they have been diminished by the fisheries about Booth Bay.

Mr. Kenniston states that in the town of Booth Bay, in 1873, 152,000 barrels were taken by five factories, as follows: Kenniston, Cobb & Co., 17,000; Gallup & Holmes, 17,000; Gallup & Manchester, 25,000; Suffolk Oil Works, 48,000; Atlantic Oil Works, 45,000. In 1872 the aggregate reached 110,000 barrels; in 1871, with six factories, about 95,000; in

* Boston Semi-Weekly Advertiser, August 27, 1872.

1870, less than 75,000; while in 1866, the first year of the work, only about 35,000 barrels were taken. Judson Tarr & Co. think that they are more plenty than ever before, but not so numerous inshore.

Mr. Edward E. Race, of East Booth Bay, Me., reports, November 5, 1877, the total catch for the season in that vicinity at 156,000 barrels, or 51,948,000 fish.

Mr. W. A. Abbe, manager of the Pemaquid Oil Company, states that the season of 1877 was a poor one, both in the number and quality of the fish taken. The company's fleet of five steamers took during the season over 61,000 barrels (20,000,000 of fish), yielding about 127,000 gallons of oil and 1,800 tons of guano. The fishing began off Gloucester, thence extended to the coast of Maine, and ended off Provincetown. Some of the steamers fished for other parties after the close of the Provincetown season off Newport and Sandy Hook, but the catch was insignificant.

The three steamers owned by Edward T. Deblois took, in 1877, on the coast of Maine, 26,649 barrels (9,000,000 of fish).

Mr. George Devoll, of Fall River, Mass., fishing in 1877 for the Narragansett and Atlantic Oil Works in Maine, caught from his steamer, the Chance Shot, about 12,000 barrels of menhaden.

In 1877, Gallup & Holmes took 52,000 barrels of fish on the coast of Maine and at Provincetown, besides 8,000 barrels caught and sold further west. These fish yielded 120,000 gallons of oil and 1,500 tons of guano.

On the coast of New Hampshire.

105. Mr. Chandler Martin, of Whale's-Back Light, near Portsmouth, N. H., in his communication of February 23, 1874, reported that the fish were diminished January 9, 1875; he writes that they were more abundant in 1874 than for ten years previous, and that they are probably not affected by the fisheries.

Mr. Winslow P. Eayrs, of Nashua, N. H., calls attention to the rapid diminution of the pogies in that vicinity, attributing it to the extensive operations of the oil-factories and to the pollution of the waters by the refuse dye-stuffs and chemicals from the factories.*

On the coast of Massachusetts.

106. Mr. W. W. Marshall estimates the catch of gill-nets at Rockport, 1877, at 1,000 barrels. The fisheries at Newburyport are described below.

According to Mr. Babson the pogies are more numerous about Cape Ann than any other fish except herring and mackerel. He thinks they have decreased somewhat during the past ten years and keep more off the shore. Statistics of capture are given elsewhere.

* Report of the Commissioner of Fish and Fisheries for 1871-'72, p. 136.

About Marblehead, Mass., says Mr. Dodge, they are greatly diminished and are less numerous than most other species.

Mr. Horatio Babson states that the value of the catch of menhaden off Gloucester in 1876 was nearly \$800,000. Mr. George W. Plumer estimates \$750,000 for the New England coast. George Norwood estimates its value at from \$300,000 to \$500,000.

Capt. Charles C. Pettingell estimates the number taken in Salem Harbor at 2,000 barrels. This is probably below the actual figure.

Mr. Horace M. Merchant, of Lanesville, Mass., estimates the catch in that vicinity at 750 barrels. They are taken mostly by gill-nets, 300 of which are in use, and are sold for bait.

Mr. J. G. Pond, of Provincetown, estimates 1,000 barrels for that port.

At Plymouth, Mass., according to Mr. Thomas Loring, the menhaden are very few and are diminishing.

About Wellfleet, Mass., states Mr. Dill, the number is greatly diminished on account of the bluefish; they are not so numerous as the mackerel; the capture for the past eight years (in 1873) has been about \$500 worth a year. In 1874 about 6,000 barrels were taken in the bay. Fishing does not appear to diminish their numbers.

Capt. Hanson Graham and Capt. Zephaniah P. Lanman estimate the catch of Wellfleet for 1877 at 20 barrels. This is far too small.

Capt. Henry E. Hatch, of North Eastham, Mass., states that many menhaden are taken in the pounds of that neighborhood.

Capt. Solomon Dinnel, of East Orleans, thinks that 100 barrels are taken in the gill-nets belonging in that town.

At Provincetown and Truro, Mass., according to Mr. David F. Loring, the fish are greatly diminished; they are more numerous than any other fish in late April and May. Only 1,000 to 2,000 barrels were taken in 1873.

At Chatham they are more numerous than any other fish, though they do not enter the bay so plentifully as in former years. From 3,000 to 5,000 barrels have been taken annually for the past six years. Captain Hardy does not think that their abundance is affected by the fisheries.

Mr. Kenney states that at Nantucket pogies are the most numerous fish. They vary in abundance from year to year but for the past ten years, as a whole, their numbers remain about the same. Fishing does not affect them. On the other hand Capt. S. H. Winslow, line fisherman, testifies: "The menhaden are very scarce now (July 19, 1871), and I think we shall lose them too very soon, because they are using them up for oil.* In this month and from the 20th of June the ocean used to appear to be literally covered with menhaden. Now there are not a quarter as many as there used to be. People think they are plenty because by using a purse-net one or two hundred fathoms long they can purse several hundred barrels at a haul."

* Report of United States Commissioner of Fish and Fisheries, 1871-'72, p. 46.

N. B. Tower, of Cohasset, states that menhaden are taken in the weirs located in that town. Mr. A. J. Hathaway estimates the annual catch at 10 barrels.

John W. Cook, of South Dartmouth, estimates the catch for 1877 at 30,000 barrels or 9,990,000 fish.

Warren A. Gifford, of Dartmouth, puts the catch of that town at 465 barrels.

Capt. Darius F. Weekes, of South Harwich, reports "thousands of barrels."

Capt. Remark Chase, of West Harwich, who sets a small weir for shad, herring, and pogies, reports about 2,000 barrels of the latter.

At South Westport, according to Capt. John W. Gifford, there are five seines 120 fathoms long and 20 feet deep used in the capture of menhaden. Their average annual catch is about 300 barrels. Mr. Gifford thinks that 1,500 barrels are taken annually in Westport.

Capt. Eldad Gill, of North Eastham, estimates the catch for that place at three or four barrels.

Mr. Alonzo F. Lathrop, of Hyannis, Mass., thinks that the number of pogies is increasing, though it was not so great in 1873 as in 1874 or the preceding years. They are quite as numerous as other fish, and are not perceptibly affected by fishing. Alexander Crowell testified June 29, 1871, that menhaden were more scarce.*

At Edgartown, Mass., and about Martha's Vineyard, they are more numerous than any other species. Five thousand barrels were taken in 1873 by the pounds; 10,000 in 1872. Fishing is not thought to affect their abundance. According to Mr. Marchant and Mr. Luce, they are not more or less abundant than they were ten years ago.

In the weir at Menemsha Bight, owned by Jason Luce & Co., the number of barrels of menhaden taken in 1869 (April 4 to June 7) was 1,590; in 1870 (April 14 to June 8), 1,375; in 1871 (April 14 to June 9), 3,200; in 1872, 3,800.

At a conference on the subject of fisheries at Edgartown, Martha's Vineyard, September 27, 1871, Captain Rease, acting as spokesman for a number of other fishermen, gave the following testimony:

"The law ought to be uniform. One reason why the pounds were not stopped by the legislature of Massachusetts was, that the Provincetown people made a statement that they could not fit out their vessels with bait unless they had pounds to catch it for them.

"Question. Could they?

"Answer. How did they do it before? They had the same facilities then as now. They used to send to Nova Scotia for bait; now they use only menhaden and herring for bait. Menhaden are getting scarce. The harbor used to be full when I was a boy; but it is a rare thing to find any here now, because they are caught up. They don't catch them at Saughkonet Rocks as they used to. If they keep on catching them up

* Report of United States Commissioner of Fish and Fisheries, 1871-'72, p. 49.

as they have done, we shall have to send to California to get a mess of fish.”*

At Waquoit weir, near Wood’s Hole, Mass., the number of menhaden taken in 1865 was 211,100; in 1866, 318,510; in 1867, 203,740; in 1868, 124,726; in 1869, 145,710; in 1870, 407,930; in 1871, 235,270.†

On the north side of Cape Cod, in Massachusetts, there are 19 weirs; 10 of these were estimated to have yielded in 1876 16,236 menhaden, giving an average of 1,624 to a weir, making an aggregate for the whole of about 32,480. On the south side of Cape Cod, in 1876, were 22 weirs; 10 of these yielded 1,827,729, and the total yield is estimated at 4,000,000. The number of weirs in Martha’s Vineyard Sound is 9; 6 of these yielded 1,395,270, and the total yield is estimated at 2,093,000. The number of weirs in Buzzard’s Bay is 30; the yield of 11 in 1876 was 54,878,000, and the total yield is estimated at 162,000,000. The total amount taken in the weirs of Massachusetts is estimated at about 170,000,000.

The returns of the catch of these same weirs in 1877, as given in the Report of the Commissioners of Inland Fisheries, is as follows:

Weirs.....	1, 770, 136
Gill-nets	81, 256
Seines	600, 198

While the estimate given above is perhaps too large, the returns cited are probably much too small.

On the coast of Rhode Island.

107. Mr. Edwin A. Perrin, postmaster, Pawtucket, R. I., puts the catch of the five drag-seines there owned, at 2,500 barrels.

Mr. Daniel T. Church writes: “There are no fish in Narragansett Bay so plenty as menhaden if we take several years as the standard, but if we should take years as they come and name each year separately it would be different. For instance, during 1871, 1872, and 1873, scup appeared in Narragansett Bay in immense quantities. There is no doubt in my mind that there has been, during the years named, more of them than menhaden. But, for a number of years preceding, scup were scarce. A few years since squeteague were more plenty than menhaden, for the bay seemed to be full of them from near Providence to Point Judith, and from Secomet to Somerset. Menhaden, as an average, have been plenty in Narragansett Bay for the last ten years; but not far from ten years back they were scarce, and some of the fishermen left the business on that account. It is my opinion that the blue-fish were so plenty as to destroy the menhaden in large numbers. It was seriously feared that they were to disappear; but since blue-fish, sharks, and horse-mackerel,

* Testimony in regard to the present condition of the fisheries, taken in 1871. <Report of U. S. Commissioner of Fish and Fisheries, 1871, pp. 39, 40.

† Report of Massachusetts Commissioners of Inland Fisheries for 1871, and Report of United States Commissioner of Fish and Fisheries, 1871-72, p. 176.

have become, for some unknown reason, scarce, menhaden have grown plenty, and 1871, 1872, and 1873 have been great years in the business. Taking for a basis of estimate that there are eight menhaden factories in Narragansett Bay that use about 20,000 barrels each, it would make the number of barrels caught during the year 1873 about 160,000. We do not think fishermen have any perceptible effect on menhaden, for it is a fact well known that a few years back they were so scarce that boats and seines were in the market at less than half their value. The year 1873 has been the year of surprise and wonder of all years, for the sea has been one blanket of menhaden from the Chesapeake to the Bay of Fundy."

Lieutenant-Governor Stevens, of Rhode Island, who owns a pound in Narragansett Bay, found menhaden more plentiful in 1871 than for many years before.*

Mr. Joshua T. Dodge, of New Shoreham, R. I. (Block Island), writes that menhaden are very plenty, though they are scarce in particular seasons; 1873 was a very good year for them. The fish do not seem to be less numerous, but they are wilder than formerly.

Captain Crandall is of the opinion that about Watch Hill, though still more numerous than other fish, they are considerably diminished in number by the use of seines. The catch of 25 drag-seines, owned in that vicinity, was estimated for 1877 at 100 barrels.

On the coast of Connecticut.

108. Captains Wilcox and Potter, of Mystic Bridge, Conn., think that there is no perceptible decrease in the numbers of bony fish on account of the fisheries, and that they are on the increase. They estimate the amount taken in the neighborhood (from Stonington to Poquannock) in 1873 at 6,500; in 1874 at 109,000 barrels.

Captain Washington, of Mystic River, Conn., is unable to see any decrease of late years.

Capt. S. G. Beebe, of Niantic, thinks that the fish are on the increase, and are more abundant than any other species. He estimates the number taken by Luce Brothers in 1873, three seines, 9,000,000; in 1872, four seines, 13,000,000; 1871, four seines, 17,000,000.

At Saybrook, according to Mr. R. E. Ingham, there is no decrease, and the fish are more abundant than any others.

It is the opinion of Mr. H. L. Dudley that there has been no actual decrease. The wears in the vicinity of New Haven have been as successful in 1877 as in any previous year. In 1871, when the Pine Island fishermen captured 10,000,000 they thought the climax had been reached, but in 1876 the quantity was increased to 18,000,000. The catch for seven years is approximately as follows:

1871	10, 000, 000
1872	13, 000, 000

* Report of Commissioner of Fish and Fisheries, 1871-'72, p. 19.

1873	11,000,000
1874	10,000,000
1875	*12,000,000
1876	18,000,000
1877	14,000,000

In 1869, Miles Brothers, of Milford, Conn., are said to have taken 8,000,000 or 10,000,000 of fish; a season's catch which has not yet been exceeded, although their facilities for fishing have been greatly increased.

A correspondent of the *American Agriculturist* wrote to that paper in 1873,† that during the season of 1872 the factories between New London and Stonington caught 40,800,000 fish, which yielded about 142,000 gallons of oil and 4,080 tons of scrap.

The season of 1877 has been an eminently successful one for the fishermen of Long Island Sound. From Pine Island Mr. Dudley counted at one time 30 schools of fish. This year, however, the fishing has been most successful around and outside of Montauk Point.

Gurdon S. Allyn & Co., with three seines worked from sloops took in 1877, 13,000,000 of fish, yielding 42,000 gallons of oil.

Luce Brothers, of East Lyme, Conn., with one steamer and nine sloops, with 48 men, took in 1877, 3,800,000, fish producing 103,200 gallons of oil.

There are eighteen weirs in the harbor of Westbrook, Conn., which take, according to Capt. J. L. Stokes, about 8,000 shad and 500,000 menhaden each, giving an annual yield of 141,000 shad and 9,000,000 menhaden. This is probably rather an overestimate. The Westbrook weirs have leaders of 250 to 500 fathoms, and are managed by four men each. The menhaden taken in them are sold to farmers.

The following are the returns of George Stannard & Co.'s pound at the mouth of the Connecticut:

Year.	Shad.	Small shad.	Whitefish.	Alewives.
				<i>Barrels.</i>
1858	1,200	.....	446,090	15
1859	1,032	.....	990,600	11½
1860	1,294	.....	549,650	25½
1861	4,381	602	771,930	16½
1862	4,056	667	1,144,410	48
1863	9,400	1,655	678,070	12
1864	8,305	1,248	569,040	11½
1865	7,069	1,320	642,167	10½
1866	8,891	892	855,575	12½
1867	9,469	1,214	1,113,158	27
1868	8,781	2,212	219,070	9½

Captain Stokes, with a shore-seine of about 400 fathoms, took during the season of 1877 about 1,000,000 menhaden, which were chiefly sold to farmers at \$1.25 the thousand.

Mr. Miles, of Milford, Conn., states that there are no fish in the waters of the western part of Long Island Sound to be compared in numbers

* In 1875 the steamer was first used by the Quinnipiac Fertilizer Company.

† *American Agriculturist*, 1873, vol. xxxii, p. 139.

with the whitefish, and that so far from being diminished by capture they appear to be on the increase. The men in the employ of the George W. Miles Company, took 12,000,000 fish in 1873, 10,000,000 in 1872, 8,000,000 in 1871, and 8,000,000 in 1870.

Mr. F. Lillingston, of Stratford, states that the proportionate abundance of whitefish to any other species is about 1.000 to 1. About 5,000 barrels are taken each year. Fishing has no effect on their numbers, though previous to 1874 they were growing scarce close to the shore.

On the coast of New York.

109. In the eastern district of Long Island, according to Captain Sisson, the mossbunkers are, and seem likely to be, the most numerous species. He estimates that the number taken by purse-nets in 1873 was 50,000,000, by other nets 10,000,000. Captain Sisson.

Mr. Joseph D. Parsons, of Springs, Suffolk County, New York, estimates the total catch of 1877 at 150,000,000 of fish; 1,150,000 of these he credits to the 50 pounds and traps.

During the three months ending June 30, 1872, there were 20,000,000 of menhaden caught in Gardiner's and Peconic Bays. These fish were rendered into 14,400 gallons of oil and 1,500 tons of guano, and yielded \$80,000. The business of the year it is stated will be a failure. In 1871 the receipts of the season amounted to \$456,000.*

New York papers of August, 1872, stated that during the two weeks ending on the 17th of the month, the waters of Long Island Sound swarmed with menhaden. One fishing company took 1,300,000, realizing \$1 per thousand; another took 3,000,000. One company had rendered 5,000,000 into oil and guano during the season, not running to its full capacity. The price of the fish, formerly 60 cents per hundred, had been reduced to \$1 per thousand; yet the fishermen asserted that they could make money at the latter rate if they could sell their whole catch, but only one-third had been taken by the factories.

During 1871 24,520,000 menhaden were taken in the Eastern Long Island Bays. In less than one week, in 1872, six companies took 1,650,000. The "Cove Company" was said to have surrounded with its nets 1,000,000 at a time, but through a fault of the nets only 400,000 were taken. One of the pound nets became so full that the crew could not haul it, and the fish succeeded in breaking it loose from the stakes; it was afterward washed up on the bar. By actual count it contained over 800,000. In two weeks, in 1872, the seines took over 2,000,000.

The two steamers and three sloop-yachts of Hawkins Brothers, Jamesport, N. Y., took in the season of 1877 29,500,000 fish, yielding 82,350 gallons of oil and 3,275 tons of scrap, about one-half of which was dried fresh from the presses.

The two sloop-yachts of William Y. Fithian & Co., Napeague, N. Y.,

*Public Ledger, Philadelphia, July 17, 1872.

seined in 1877 10,500,000 fish, which yielded 24,000 gallons of oil and 1,300 tons of scrap.

The Sterling Company of Greenport, N. Y., took in 1877, with three seine-yachts and six lighters, 14,449,000 fish.

The steamers often make wonderful captures. The "Cambria," Capt. Lorenzo Tallman, is, I am informed, one of the most successful, fishing chiefly outside of Montauk. In 1876 this steamer was brought to the factory, loaded to the water's edge, thirty-six days in succession. In 1876 the "William Spicer" captured 729,300 fish in five days.

Review of the fisheries of New England since 1875, by Mr. D. T. Church.

110. Mr. D. T. Church, who is recognized to be one of the leading spirits in the menhaden fisheries, gives the following estimate of the success of the fisheries for three years past:

"1875 was a successful year; so was 1876. The year 1877 from New York to Cape Cod was the best since 1870. North of Cape Cod it was the worst since 1865. There was plenty of fish but no oil. J. Church & Co. caught, in 1876, 200,000 barrels and made over 620,000 gallons of oil. During the year 1877 they caught 183,000 barrels, and only made little over 300,000 gallons of oil. A fish called baracouta drove the menhaden from their usual feeding-grounds, and were absent until they (the baracouta) disappeared; they then put in an appearance, but too late for the factories to do much. The first taken during the summer of 1877 in Maine were from the waters of bays and rivers, and they were less than one-half as fat as they were the year before, when we took them 10 to 15 miles at sea.

"The fishermen usually steam square out to sea, and for the last ten years have found immense beds of them, and apparently inexhaustible amounts, 3 to 4 miles off shore, and generally after about the middle of July they get fat. This year the fat sea-fish could not be found at sea.

"About September 10, the baracoutas left and then they suddenly made their appearance off Portland and vicinity, and at one time the bay between Cape Elizabeth and Wood Island was packed full of the largest and fattest fish that was ever seen on this coast. Our fleet were in the midst of the schools part of two days. A storm came on, and after it was over, they were gone and were not seen afterward. It was about the 1st of October."

The baracouta referred to by Mr. Church is doubtless the tunny or horse-mackerel.

Review of the fisheries of Long Island Sound since 1870, by Mr. G. W. Miles.

111. Mr. George W. Miles, of Milford, Conn., for fifteen years engaged in the menhaden fisheries, writes:

"We cannot perceive any diminution in numbers or quantity, but we

do find a great difference at times (and some whole seasons) in size and quality.

"Our usual average catch here in Long Island Sound has been about 8,000,000 per season, beginning June 1, ending October 1. The past season, 1877, our catch was 15,000,000; nearly double the catch of previous years.

"In 1870 there was a large quantity of large fat-fish in the sound; these fish could be seen occasionally several feet under the surface by persons at the mast-head, but could not be seen by the fishermen from the deck of the vessel except occasionally. For some cause, we think they were at the bottom feeding; they did not appear on the surface sufficiently long for the fishermen to catch them until very late in the season.

"On the 10th day of August we had made only 14 barrels of oil. Some of our neighbors, having got discouraged, closed their factories, thinking there would be no catch for the season. At this time the fish suddenly made their appearance on the surface, and were caught in great abundance. They being unusually fat, yielding from 12 to 14 gallons of oil per 1,000, we made in the next six weeks 3,000 barrels prime oil.

"In 1871-'72 there was about the usual quantity of fish, yielding from 4 to 6 gallons of oil per 1,000; an average of several years previous to 1870.

"In 1873 there were immense numbers of small fish from one to two inches long appeared on the surface in the month of September; thousands of shoals could be seen at a time and great numbers in each shoal; these appeared to take possession of all the waters for the remainder of that season.

"In 1874 these small fish appeared again late in the season and were about double the size they were in 1873.

"In 1875 they appeared again much earlier; and in 1876 they came in about the 1st of June, having increased in size and numbers; apparently they occupied the whole waters of the sound, so much so, the larger fish that frequented these waters were actually crowded out of the sound, or left for other waters, and remained off Block Island, at sea, the remainder of the season, and gave up the field to be occupied by the smaller fish.

"The result of this abundance of small fish was a complete failure of the business for the two years 1875 and 1876 in Long Island Sound, the factories and fishing gears having run at great loss.

"In 1877 we provided ourselves with smaller mesh-nets and proceeded to catch the smaller fish, which had now attained a size about two thirds the average here and averaging about one-half pound each. We could catch these by using nets of $2\frac{3}{8}$ inches mesh. They were hardly worth catching, but the men could not stand another season of light catch, and there was no alternative for them; they must catch these or noth-

ing. There was not much oil in them, averaging only from $1\frac{1}{2}$ to 3 gallons per 1,000. Consequently, those manufacturers who carried on a large business barely paid their expenses."

On the coast of New Jersey.

112. At Atlantic City, New Jersey, according to Mr. A. G. Wolf, the mossbunker is the most numerous fish. About 215 barrels were taken in 1873 by Adams & Co., and about the same the previous year. The fishing does not tend to diminish their numbers

At Somers Point, Great Egg Harbor, the mossbunkers are "a thousand fold more numerous" than any other species. In 1873, 7,200 barrels were taken; in 1874, 12,000. Mr. Morris thinks that there is no decrease from fisheries or any other cause.

At Cape May, Mr. D. E. Foster writes they are more numerous than any other fish, but are not so plenty as on the eastern coast of New Jersey. As none are caught in this vicinity, the fisheries are not likely to affect their abundance, nor are they at any point south of Delaware Bay.

On the coast of Delaware.

113. About Bombay Hook, Delaware, according to Mr. J. B. Benson, the oldwife is the most numerous fish in July and August. At Mispillion River, writes Mr. James H. Bell, "they rank equal to, if they are not more abundant than, the sea-trout,* and far exceed any other fish in number: a thousand bushels of trout are sometimes taken at a haul, but the main fishing season does not last over a month, while menhaden are caught more or less during six months of the year. No diminution is noticeable, and the number seems to be about the same one year with another. These fish are not sought in this vicinity for any purpose whatever: they are caught in seines laid for other fish and are left on the beach to rot or taken home to feed hogs, or are composted for fertilizing the soil, for which they are only valuable. The quantity taken from the water never seems to affect the supply."

On the coasts of Maryland and Virginia.

114. In Tangier and Pocomoke Sounds, Maryland, the alewife is the most abundant fish. Mr. Lawson thinks that their number is decreasing from the influence of the fisheries.

At Apateague Island, Accomac County, Virginia, the alewives are more abundant than any other fishes, and are increasing, according to Mr. J. L. Anderton; and this is also the case at Cape Henry, in the opinion of Mr. Richardson.

Mr. H. L. Dudley informs me that a party of New London manufacturers, visiting the Chesapeake in 1866, found menhaden in almost incredible quantities. As he expressed it, "they were so thick that for

* *Cynoscion carolinensis*.

25 miles along the shore there was a solid flip-flap of the northward-swimming fish." One enthusiastic member of the party jumped into the water and with a dip-net threw bushels of fish upon the beach.

On the coast of North Carolina.

115. Mr. Manning writes that at Edenton, North Carolina, these fish are very few.

According to Messrs. Jennett and Simpson the fat-back is by far the most numerous species on the coast of North Carolina. Mr. Simpson writes: "Heretofore the fat-back has been only about one-third more abundant than any other species, but I have seen twice as many during the fishery season of 1873 as I ever saw of any other species on our coast. They are on the increase, and not even their wholesale destruction by the bluefish seems to affect their abundance. About fifty barrels were netted in 1873 at Cape Hatteras. In 1877, in Cape Dare County, about 300 barrels."

"At Beaufort," writes Mr. A. C. Davis, "the menhaden are more abundant than any other species and are increasing; and so it is at Body's Island, North Carolina, where 50,000 barrels were taken in 1868, the fishery having since been discontinued. About 500 barrels were taken in 1877. They are used only for fertilizing purposes."

Mr. Simpson describes their abundance at Cape Hatteras in 1874 in these words: "During the past season the fishermen provided themselves with seines and boats in time to meet the first run of the bluefish. The seines were made of cotton marlin and were about 100 yards long, 2½-inch mesh, and from 40 to 50 meshes deep. The bluefish made their first appearance on the coast from the north. The menhaden passed about three days in advance of the bluefish. I do not think I ever saw so many of this species at any one other time, or at any one other season. From the balcony of the light-house at least 25 schools might have been seen lying along the coast, both north and south of the cape. Each school seemed to cover many hundred yards of surface and to be moving south at the rate of from four to five miles an hour. This continued, and school after school followed, for ten days, before the appearance of the bluefish; and when the bluefish did appear there seemed to be more of the menhaden with them than had passed the station during the three previous days. Hundreds of barrels, I think, were washed ashore and were driven so close by the bluefish that they had not the power to resist the surf, which was quite rough or heavy, and they were consequently thrown ashore upon the beach. Only a very small quantity of these fish were saved, as the fishermen give their attention more particularly to bluefish, but some of them were saved and salted down, when they were sold to a good advantage. Some sold as high (in trade) as to bring ten bushels of corn, equal to \$7 in currency, for one common fish-barrel of the menhaden.

"It has been generally thought by old experienced fishermen here,

that the bluefish drive the fatback south in winter, but I have learned differently during the past season from personal observation, which the following fact strongly attests. The menhaden came three days in advance of the bluefish, and entered the sound at all the principal inlets, and made their way directly for the fresh-water rivers. They could be seen as numerous in the sound heading north as they were in the sea heading south. Furthermore, by a letter from a gentleman of Plymouth, N. C., I learn that they passed that place, eight miles above the mouth of the Roanoke, in five days after passing this station; and, by another letter from Windsor, 38 to 40 miles above the entrance, I hear that they arrived there as early as the 18th of December. Thus it may be readily seen that the bluefish are not the cause of the fatback coming south. I would sooner think that the fatback caused the bluefish to come south in winter, as they generally follow in the sea, and among the last of the run of fatback.

"Last year there were not so many of the menhaden, but there were millions of young spot about two years old; but, however, this winter there was not a spot to be seen."

Dr. H. C. Yarrow found enormous schools of very small menhaden about Fort Macon, N. C., December 31, 1871.

Dr. Elliott Coues, U. S. A., states that they appear in great numbers about the harbor at Fort Macon, N. C., in spring and summer.*

On the coast of Florida.

116. In the Saint John's River, Florida, the menhaden are more abundant than any other fish, and apparently on the increase. They clog the shad-nets in the spring.

Summation of evidence.

117. The statements above quoted seem to indicate that the menhaden is by far the most abundant fish on the eastern coast of the United States. There is, moreover, no evidence whatever of any decrease in their numbers. They are apparently quite as abundant as any species on the eastern coast of the United States, not even excepting the cod, herring, and mackerel. There are, however, no data for definite comparison, nor is there any means of determining the ratio of increase or decrease within a given period of years. The same must be said regarding the effects of the wholesale capture going on every year on certain parts of the coast, for the present perfection of fishing apparatus and the skill of the fishermen is likely to prevent any apparent diminution in the yearly returns of the fisheries, even though the species be gradually approaching extinction. It is quite evident that with the improved methods now in use a much larger proportion of the fish frequenting any given body of water may be taken than was formerly possible.

* Notes on the natural history of Fort Macon, N. C. <Proc. Phil. Academy of Natural Sciences.

18.—ABUNDANCE IN THE FUTURE.

The probability of future decrease.

118. There is no evidence of a decrease in the abundance of menhaden during a period of fifteen or more years of fisheries conducted on an immense scale. It seems, therefore, that no one can reasonably predict a decrease in the future. The movements of marine fishes are capricious in the extreme. The only cases in which the fisheries have been clearly shown to exercise a pernicious effect is where the spawning fish are taken in great quantities. It has been clearly determined that the menhaden are never captured upon their spawning-beds.

F.—FOOD.

19.—FOOD OF THE MENHADEN.

The opinions of fishermen.

119. Fishermen generally say that the menhaden feed on "brit" and "seed," "red-seed," "cayenne," or "bony-fish feed." These are sailors' names for small floating animals of any kind, such as the minute crustacea, mostly entomostracans (*ostracoda* and *copeopoda*), which swarm the surface of the North Atlantic and are the favorite food of mackerel, herring, and many smaller species. They describe this food as "something of a red or green color and about the size of hay-seed," and very naturally suppose the menhaden to be feeding upon it when they are swimming with their heads at the surface. Others think that they "live by suction," meaning that they feed by drawing through the mouth water containing particles of organic matter. The sturgeons, pipe-fish, and cyprinidæ, all with toothless mouths, are supposed to have this habit. Others say that they feed upon the jelly-fishes (*acalephæ*),* upon the "mossy substance" which clings to the eel-grass (*Zostera marina*), and upon the "scum" or "mucus" which floats on the surface. Perhaps all are right, for most fishes relish changes of diet. At Greenport, N. Y., according to Mr. W. S. Havens, the slimy coating of the eel-grass (which is composed of small algæ, *Spyridia filamentosa*, with various species of *Polysiphonia* and *Ceramium*, &c., often clogged with a soft, slimy deposit) is known as "bunker-feed."

Peculiar movements of the menhaden.

120. Captain Loring has seen the menhaden in Provincetown Harbor in groups of from 20 to 500 gathered among the eel-grass in shoal water, swimming around and around in circles. He supposed them to be spawning, but it seems quite probable that they were feeding. Mr. Hance Lawson states that in Chesapeake Bay the schools break up into small

* *Acalephæ* do not have the appearance of being nutritious food, but the fattest hogs I have seen in Florida are those at Mayport, which greedily devour a large species of discophore which is cast on the beach in great quantities.

bodies at night, coming in-shore to feed and dispersing into deep water in the morning. Mr. Simpson states that in spring and summer they subsist principally upon mud and scum from the surface of the water, which they obtain by feeding in muddy slues and channels on the ebb, and grassy rivers and shoals on flood-tide.

The examination of stomach-contents.

121. The examination of the stomachs of a hundred or more menhaden, just from the water, taken off Portland, Me., in Block Island Sound, at the mouth of the Potomac, and in the Saint John's River, Fla., has failed to reveal any traces whatever of animal food. Mackerel examined at the same time, in Maine, contained numerous specimens of "seed," which were mostly a large entomostracan (*Irenaus Pattersonii*), and small shrimp (*Thysanopoda*, sp.). Every menhaden stomach which I have opened has been found full of a dark greenish or brownish mud or silt such as is found near the mouths of rivers and on the bottom of still bays and estuaries. When this mud is allowed to stand for a time in clear water, the latter is slightly tinged with green, indicating the presence of chlorophyl, perhaps derived from the green algæ so common on muddy bottoms. A microscopic examination by Dr. Emil Besseles brought to light, in addition to the particles of fine mud, a few common forms of diatoms.*

Inferences from these examinations.

122. Perhaps no decided opinion should be formed without additional data, but the plain inference seems to be that the food of the menhaden, in part at least, is the sediment which gathers upon the bottom of still, protected bays, which is largely composed of organic matter, and upon the vegetation which grows in such water. Upon what they feed during their long sojourn at sea there are no sufficient grounds for conjecture, though it is quite possibly the soft gray ooze and mud which recent explorations of the depths of the Atlantic have shown to exist at every depth, and on the numerous protozoans and *Bathybius*-like substances there flourishing. The peculiar digestive organs of the menhaden were described in paragraph 53.

Professor Verrill on bottom-mud.

123. In remarks upon the characteristics of different deposits of mud, Professor Verrill writes as follows:

"In some cases, especially in well sheltered localities, where the water is tolerably pure, the mud may contain large quantities of living and

* "A large number of specimens [of menhaden] freshly caught in seines were examined, and all were found to have their stomachs filled with *large quantities of dark mud*. They undoubtedly swallow this mud for the sake of the microscopic animal and vegetable organisms that it contains. Their complicated and capacious digestive apparatus seems well adapted for this crude and bulky food." (Prof. A. E. Verrill, in *American Naturalist*, 1871.)

dead microscopic organisms, both animal and vegetable, and these may even constitute more than one-half of the bulk of the mud, which, in such cases, is peculiarly soft and flocculent; such mud is extremely favorable to many kinds of animals that feed on the microscopic organisms, especially the bivalve shells, holothurians, and many annelids, and the 'menhaden' among fishes. The last variety of bottom, when it has a substratum of sand or gravel a few inches below the surface, is the most favorable kind for oysters, which grow very rapidly and become very fat in such places." *

The evolutions of the schools.

124. Why do the menhaden, when in deep water, swim from morning to night with their mouths at the surface? Perhaps, with their widely expanded jaws and the complicated straining apparatus formed by their gill-rakers they are able to gather nutritious food which is floating on the water. To be convinced that this is possible, one needs only to observe the immense "slicks" of oily matter, often miles in extent, remnants of the bloody feasts which bluefish and bonito have made on other fish, generally the menhaden. An insight into the habit may be gained by watching the menhaden at the head of New Bedford Harbor, near the mouths of the large city sewers. Here a school of these fish is said to be invariably found circling around near the surface with open mouths, apparently in the act of feeding.

Whatever may be the character of their food, their rapid increase in size and oiliness indicates that there is an abundant supply in our waters.

Mr. J. Carson Brevoort states that he has seen menhaden plunging among the floating beds of jelly-fishes. He infers that they feed upon these creatures, though he has not seen the entire act.

The value of menhaden for bait affected by their food.

125. Fish taken in Salem Harbor are not considered good bait. Something in the food which is there obtained renders them very liable to decay, and however carefully they may be packed in ice the viscera soon rot away. A similar phenomenon is well known to the herring fishermen of the coast of Norway, where a certain kind of food, presumably larval forms of small mollusks, often eaten by the herring, causes the fish to decay, in spite of the utmost precaution in salting. It is the custom of these fishermen to keep these fish alive in the nets for several days, to allow them to "work off" this undesirable food. Perhaps a similar precaution might be useful to the Salem Harbor fishing gangs.

G.—REPRODUCTION.

20.—STUDIES OF THE PARENT FISH.

Dissections of Connecticut fish.

126. Of the breeding habits of the menhaden, like those of the bluefish, nothing definite is known. Hundreds of specimens have been ex-

amined in the north by the naturalists of the Fish Commission, between the months of June and November, and in the south in March and April, without in a single instance discovering matured spawn, so it may be regarded as a demonstrated fact that the species does not breed upon the coast of New England and New York. A large number dissected by me at Noank, Conn., in July and August, 1874, had the ovaries and spermaries partially developed, but still far from maturity, and it seemed probable that three or four months would pass before spawning time.

Others examined at Pine Island, Groton, Conn., October 30, 1877, had the ova more mature, but at least six weeks or two months from perfection, as nearly as I could estimate. The fish then examined were taken in the last runs of the fall, and were supposed to be the Maine schools on their southward migration.

Dissections of Maine fish.

127. Boardman and others state that in the last week in September fish taken in Boothbay had spawn and milt so slightly developed that only persons accustomed to the examination of such subjects could distinguish the sexes.*

The number of eggs in immature ovaries.

128. Hon. S. L. Goodale took the ovaries from a large number of menhaden at Boothbay, September 14, 1876, three to five days before their autumnal departure from the coast. Twelve hundred fishes were examined, and only three were found to contain ovaries which approached

* The following letter by Mr. Atkins was received while this report was being printed:

"BUCKSPORT, MAINE, June 4, 1878.

"DEAR SIR: I have discovered something about menhaden which is new to me.

"A short time ago a fisherman sent me a menhaden caught in Verona, an adjoining town to Bucksport, which turned out to be a male adult, with well developed spermaries, weighing $\frac{9}{10}$ ounces, the whole fish weighing $11\frac{1}{2}$ ounces; 10 inches long. To-day I have another specimen, also taken in Verona, which turns out to be a female, 11 inches long, with fully developed ovaries, which I have not yet weighed, but which contain eggs a little more than half a millimeter in diameter. I should think they would count out 200,000 or more.

"Another Verona fisherman, Mr. Dudley Abbott, says that last year he slivered a lot of menhaden, and should judge that one-third or one-half of them contained spawn; previous to last year he had seen menhaden with spawn occasionally, but not often he thought; continued to find some such till August last year.

"Mr. Harrison Heath, who sent me the female before me, told me yesterday that he had observed these 'pogies' with spawn for three years past, but did not recollect seeing them before; thought they were plentiest last year.

"You will recollect that I stated to you some months ago that the smelt fishermen reported that last fall they caught considerable numbers of young menhaden of various sizes—small at first and a good deal larger the first of winter—and that it was quite uncommon for so many of them to be taken.

"If these facts are sufficiently interesting, I will endeavor to follow the matter up.

"Very truly, yours,

"C. G. ATKINS."

maturity. These ovaries are deposited in the United States National Museum (Cat. No. 16946). I examined the ripest of them in order to estimate the number of ova. The ovaries with their membranes weighed 17,570 milligrams, or 271.140 grains (0.62 ounce). A portion weighing 420 milligrams was detached. This was found to contain approximately 250 ova, giving to each an average weight of one milligram and eight-tenths. The estimated total number of ova is 9,760, or in round numbers 10,000, which is close enough for all probable necessities. There is no indication of the size of fish from which the ovaries were taken. I am informed by Mr. Milner and Dr. Bean that in the shad and whitefish the number of eggs varies with the weight of the parent. In the latter species a mother fish of one pound weight will yield 20,000 eggs, and one of twice that weight double the number of eggs. This enumeration of the menhaden eggs merely serves to show that, comparatively, the species is not exceedingly prolific.

I am not aware that the number of ova in the ovary of the menhaden has ever before been accurately determined. Mr. Joseph D. Parsons, of Springs, Suffolk County, New York, writes that 70,000 have been counted. Mr. Walter Wells, of Portland, Me., states that he has somewhere heard of two millions having been counted. Several writers have lately expatiated on the immense fecundity of the menhaden. This has not yet been established.

No mature ova have been observed.

129. From Maine to Florida there can be found very little satisfactory evidence that spawn fully ripe has been seen, or that spawn or milt ever has been observed to run from the fish when handled after capture.

An instructive circumstance is mentioned by Mr. Bell, of Mispillion River, Delaware Bay, who states that after the last of these fish had disappeared from those waters, about the 7th of November, 1874, the bay from Cape May to Cape Henlopen and eighteen miles above its mouth was crowded with the largest menhaden ever seen on the coast, many of them equalling a medium-sized shad, and nearly three-fourths of them pregnant with large and nearly matured roe. They had been driven in by the bluefish which destroyed and pursued them ashore in vast numbers. Sixty hours after the arrival of the menhaden not one was to be found on the coast.

According to Captain Atwood, of Provincetown, some menhaden taken at that place in December had mature spawn.* He suggests that these fish, which were very few in number, may have been detained in the creeks by accident.

A statement by Mr. Atkins.

130. Boardman and Atkins, apparently quoting from Mr. George B. Kenniston, state that off the coast of Virginia, about Christmas, the

* Proceedings of the Boston Society of Natural History, vol. x, p. 67.

females can be readily distinguished by the distension of the abdomen; both sexes are so ripe that eggs and milt can be easily pressed from them. In Chesapeake Bay, in early spring, just after the advent of the adult fish, great schools of the young are seen, thought to be one and a half or two inches long. These little ones huddle together in dense schools, preyed upon by shovel-nosed sharks and other enemies. They are bound, so far as can be seen, in no particular direction, and are not supposed to come further north, but to pass the summer there and leave in the fall greatly increased in size. The color of these young fish, when seen in mass, is black, instead of red, which is the color of a school of adults when seen beneath the surface. These statements are not authenticated by the name of the observer, and must be received with caution.

21.—STUDIES OF THE YOUNG FISH.

The young fish in Southern New England.

131. Young fish from four to six inches long make their appearance in vast numbers a few weeks after the arrival of the adult fish. So extensive are the schools that experienced fishermen are sometimes deceived, mistaking them for schools of large fish, and make every preparation for setting their nets. These little fish play up into the shallow coves and the brackish water at the mouths of rivers and become an easy prey to small bluefish, eels, flatfish, and other small fishes.

Youngmenhadenseldom round Cape Cod, though they are not uncommon in Provincetown Harbor in September, where the fishermen catch them in dip-nets for bait. They have never been seen on the coast of Maine. Mr. Dodge states that they are occasionally seen in coves near Marblehead, Mass., and Mr. Babson has seen schools of half-grown fish at rare intervals about Cape Ann. In the museum of the Peabody Academy of Sciences, at Salem, is a bottle containing specimens about three inches long taken in Salem Harbor. South of Cape Cod, as far as Cape Hatteras, they swarm in the waters in late summer and autumn, and in the Saint John's River, Florida, the creeks and coves are alive with them in summer and early autumn. In the harbor of Beaufort, S. C., they are said to occur in December.

These schools of small fish, some of them little over an inch in length, suddenly make their appearance in the bays of the Vineyard and Fisher's Island Sounds about the middle of August. It may be regarded as certain that they are not hatched from the eggs in these localities, because for several seasons the ground has been thoroughly explored daily for two months before the appearance of these fish without finding a trace of fish of smaller size.

Locomotive powers of the young menhaden.

132. It has been suggested that young menhaden, less than two inches in length, cannot be thought to have traveled from the Virginia coast, a

distance of three hundred miles, nor even fifty miles, and from this it is argued that some of the species must spawn not far from the Vineyard Sound. It is not impossible that this conclusion may be true, still the premises are hardly sufficient. The young menhaden at the time of their first appearance on the southern coast of Massachusetts are strong and active, and apparently fully developed in bone and muscle. There is no apparent reason why they might not make long journeys.

22.—INFERENCES AS TO TIME AND PLACE OF SPAWNING.

The testimony of young and parent fish.

133. Certain inferences may perhaps be drawn from the facts mentioned above. The menhaden taken in summer and early autumn on the coast of New England show ovaries and spermaries in an undeveloped state, but evidently slowly approaching maturity, while others accidentally delayed in Cape Cod Bay and Delaware Bay show in November spawn nearly ripe and in December ova quite mature. In October the southward migration begins, and by the 1st of December they have deserted the coasts of the Northern and Middle States. These schools winter, in part, on the coast of North Carolina, where they arrive in large numbers from the last of November to the middle of December, and are also found throughout the winter on the coast of Florida. The young fish, from one to three inches in length and upward, are common throughout the summer on the southern coasts, and those of a larger growth, from five to eight inches, occur in late summer and autumn on the coast of Southern New England south of Cape Cod. There is no satisfactory evidence that spawning takes place in the rivers of the Southern States. Will not these considerations warrant the hypothesis that the breeding-grounds of the menhaden are on shoals along the coast, from North Carolina, and perhaps Florida, northward as far perhaps as Virginia or New Jersey? This idea was first advanced by Captain Atwood and has received the sanction of Messrs. Goodale and Atkins.

The opinions of fishermen.

134. The majority of intelligent fishermen in the North seem to believe that the menhaden is a winter spawner, breeding in Southern waters, though some, arguing from the presence of small fish in autumn, advance the idea that they spawn in Long Island Sound and Narragansett Bay, while others still think it probable that there are two spawning seasons, one at the north in the summer and another in the winter at the south. I have been assured by several fishermen that when seining menhaden they have found a mass of their spawn, two or three feet in diameter, carried in the center of the school, and the idea was advanced that the fish transported and in this way cared for their eggs until they should be hatched.

I have had the opportunity of examining one of these supposed

masses of menhaden spawn, which proved to be a cluster of squid (*Loligo Pealii*) eggs, and it is probable that these singular objects have given rise to all similar stories.

A claim that menhaden spawn in Southern rivers.

135. The young menhaden which frequent the coasts north of the Carolinas are usually four or five inches in length, and there is no record of their having been seen of a less size than three inches, and these are probably the fish hatched from the eggs during the winter, which, in obedience to the migratory instinct, move northward along the coast. The movements of the schools of young resemble in every respect those of the grown fish, and they approach the shore from deep water by the same routes. At Cape Hatteras, according to Mr. Simpson, the young fish from one inch upward are seen throughout the summer, which points clearly to a proximity to the spawning-ground at that point. In the Saint John's River they are found two inches in length. It is the opinion of Mr. Kemps that many of the menhaden spawn in the river, and he is positive that he has seen spawn running from the fish taken in the early part of the year. The presence of the young fish in the waters, however, does not necessarily point to that conclusion, as he very naturally supposes it to do.

Mr. Simpson believes them to spawn in the Neuse River, but this is not proven to be a true supposition.

Criticism of a statement by Professor Hind.

136. In this connection I must call attention to a misapprehension on the part of my friend Professor Hind, who, basing his conclusions upon some uncollated returns in Professor Baird's first report, states that the spawning period of the menhaden is in the spring, at which time it appears to come from its winter home in the deeper waters off the coast to the shores, at dates corresponding to those of others whose movements are governed by temperatures.* And again he states, without citing any authority, that "following the law which govern fish life, its mode of spawning resembles that of the typical herring." This may or may not be true. No one knows.

23.—THE FEASIBILITY OF ARTIFICIAL CULTURE.

A claim that menhaden may be acclimated in Northern waters.

137. In a report to the minister of marine and fisheries, Mr. J. G. Whiteaves remarks: "It would perhaps be desirable to try and acclimatize menhaden in British waters. All that would be necessary would be to send a vessel or two, each provided with well-room, to the United States, and liberate the menhaden thence procured at the mouth of any of the New Brunswick or Nova Scotia rivers, such as Saint Andrew's

* The effect of the fishery clauses of the Treaty of Washington, &c., 1877, p. 73.

Bay, L'Etang, Lepreaux, or Musquash, in New Brunswick, or Saint Mary's Bay and its tributaries, or Tusket River, in Nova Scotia."*

In his report for 1873, Mr. Peter Mitchell, minister of marine and fisheries, announces that he intends to suggest the artificial production of bait for the deep-sea fisheries on some part of the coast of Nova Scotia, and to devote attention especially to the growth of the menhaden and other bait-fishes of that class.†

In the "Case of Her Majesty's Government," before the Halifax Commission (see below in paragraph 219), the claim is made that "the menhaden bait itself can be bred and restored to places in the Bay of Fundy on the coast of Nova Scotia, where it existed up to the time of its extermination."

With regard to these claims it can only be said that they are untrue and unsound. No one having the slightest acquaintance with the principles of fish culture would entertain the idea of the feasibility of such schemes.

H.—ENEMIES AND FATALITIES.

24.—DISEASES.

Mortality in the Merrimac River.

138. Capt. Moses Pettingell tells me that great mortality often prevails among the menhaden at the mouth of the Merrimac River. In 1876 the dead fish were heaped upon the shore to a depth of two feet, and the municipal authorities of Newburyport expended a large sum of money in carting them away. The fish seem to die in great pain; they come first to the surface, then, after a severe flurry, die. They sink immediately to the bottom, but float at the surface after a day or two.

It is stated that the same mortality prevailed forty years ago as now among the menhaden in the Merrimac. They covered the shores, tainted the air, and were taken away by the farmers as dressing for land. It was noticed that the fish would come to the surface, spin around and around, and then turn over on the back and die.‡ These strange deaths are very probably caused by the presence of some internal parasite.

25.—PARASITES OF THE MENHADEN.

The crustacean, Cymothoa prægustator.

139. Some of the parasites which infest the menhaden are particularly curious and interesting.

The name "bug-fish," commonly applied to the menhaden in the Southern States, has reference to a large parasitic crustacean frequently

* Sixth Annual Report of the Department of Marine and Fisheries, 1874, appendices of the fisheries branch, p. 196.

† Fifth Annual Report, &c., p. 66.

‡ Springfield Republican, August 21, 1871.

found in the mouth of this fish. This parasite appears to have been first described by Latrobe, who proposed for it the name *Oniscus prægustator*.* Say subsequently referred it to the genus, *Cymothoa*.† It is known to the fishermen as the "bug," "fish-louse," or "crab-louse," and belongs to the order of Isopoda or equal-footed crustaceans, familiar examples of which are the whale-lice (*Cyamus ceti*, &c.) and the boring shrimps (*Limnoria lignorum*) which riddle so completely the planks of ships and other submerged timbers, or, better still, the "wood-lice," "saw-bugs," or "pill-bugs" to be found in any old cellar or wall and under stones and logs which have lain for a time on damp ground. Verrill and Smith‡ give twenty-three marine species for the coast of Southern New England. Most of these inhabit the rocky shores, clinging to the roots and branches of rock-weed or crawling among the rocks near high-water mark. Three are parasitic, one upon the bluefish, one upon the orange filefish; a third was found by Professor Leidy in the gill cavity of a hermit-crab (*Gelasimus pugilator*). *Cymothoa prægustator*§ resembles in its shape a large "pill-bug," the females reaching the length of two inches, the males somewhat smaller; they are provided with seven pairs of legs, with claws sharply pointed and adapted for clinging to their protector; their color is dirty white. The females carry their eggs in a large pouch on the under side of the body, formed by a series of large scaly plates, where they are retained until the young are hatched and large enough to care for themselves. The *Cymothoa* is not in any true sense of the word a parasite, drawing nourishment from the fish to which it attaches itself; it is commensal, stealing shelter and transportation, but not subsistence, and Latrobe was very happy in his selection of a specific name, for a Roman *prægustator* was a foretaster, a cup-bearer, one who tasted the meats and drinks before they were served on the table of a prince. Clinging with its hook-like claws to the roof of the menhaden's mouth, its back downward, its mouth in close proximity to the front of the fish's upper jaw, it is in a very favorable location to take toll from every mouthful of food which passes into the brevoortian throat. It may change its quarters at will, and when the fish is dead frequently relaxes its grasp and crawls out of the mouth. Latrobe writes: "I have sometimes succeeded in taking out the insect in a brisk and lively state, but as soon as he was set free he immediately scrambled back into the mouth of the fish and resumed his position." The presence of so bulky a guest must greatly inconvenience the menhaden. I have taken from the mouth of a fish nine inches long two of these crustaceans, a male three-fourths of an inch long, and a female measuring an inch and three-

* A drawing and description of the *Clupea Tyrannus* and *Oniscus Prægustator*. By Benjamin Henry Latrobe, F. A. P. S. Transactions of the American Philosophical Society held at Philadelphia, for promoting useful knowledge. Vol. V., 1802, p. 77, pl. 1.

† Journal of the Academy of Natural Sciences of Philadelphia, Vol. 1., part II, 1818, p. 395.

‡ Report of the Commissioner of Fish and Fisheries for 1871-'72, p. 537.

§ See plate X.

quarters, the vertical diameter of whose body, with distended egg-pouch, was a half-inch; this pair of lodgers completely filled the mouth of the fish, and must have incommoded him in the act of feeding. Aside from inconveniences of this nature, the presence of the parasite does not appear to affect the well-being of the fish, those whose mouths are tenanted seeming as plump and healthy as those having apartments to let.

About seventy per cent. of the menhaden from the Potomac examined by me in November, 1874, had the *Cymothoa* in their mouths, and even a larger proportion of those in the Saint John's, in April, 1875. Say states that a large number of those in the Delaware were thus infested, and Mr. F. C. Goode writes that this is the case in the Saint John's River, Florida. The thirty-first question of the "Menhaden Circular" issued by the Commissioner of Fisheries was intended to draw out information on this point, and, from the statements of correspondents, in reply to this query, we may quite definitely conclude that this parasite of the menhaden is unknown in northern waters. Mr. A. G. Wolf, keeper of Absecum light, New Jersey, writes that a "bug" is sometimes found in the roof of the mossbunker's mouth, and almost every correspondent from localities south of that point notices its occurrence. On the other hand, it has never been observed in the waters of New England and New York. I have examined many specimens from Long Island and Block Island Sounds without finding it, and Prof. S. I. Smith tells me that his search for it in the vicinity of Great Egg Harbor, New Jersey, was equally unsuccessful. In Chesapeake Bay and the Potomac, in the Delaware River and Bay, in the inlets of North Carolina, and the Saint John's River, Florida, it is well known as the companion of the alewife or fat-back.

Capt. Robert H. Hulbert, in the latter part of May or early in June, while seining mackerel from the Ellen M. Adams, of Gloucester, near Block Island, took, with the mackerel, about a barrel of large menhaden, most of which had the parasite in their mouths. At this time most of the menhaden had gone farther north. The later a school comes in, the faster it runs to the northward, says Captain Hulbert.

Inferences to be drawn from the presence of this parasite.

140. It is not known whether *Cymothoa prægustator* is a constant companion of the menhaden, accompanying it in its migrations and dependent upon it for existence, or whether it simply seeks shelter in the mouth of the fish at a particular season of the year. Is it not possible that it may be free during a part of its life, seeking shelter perhaps during the breeding season? Latrobe found it parasitic in March; my observations were made in November. It is very important that the chasm between these dates should be bridged, for whatever the truth may be, it will throw much light upon the migrations of the menhaden. If it be a constant parasite, the presumption will be that the schools of fish which frequent the shores of the Southern States, during the summer, do not in their

winter migration come in contact with the schools from the north, otherwise the parasites would naturally be communicated. If it inhabits the mouths of the fish only while they remain inshore, and has therefore a fixed faunal relation to certain parts of the coast, it may be concluded that the menhaden of particular schools are like the anadromous fishes, restricted to particular portions of the coast, and that those schools which enter the southern inlets in spring do not proceed farther north in their migration, but remain in those localities throughout the season. Still other conclusions may be forced upon the investigator: it may be that the adult *Cymothoa* never quits its position in the mouth of the fish, and that the young only swim about in search of unoccupied quarters, and in this case it need not necessarily follow that the parasite would be communicated by southern to northern fish if they were to find their winter homes in the same waters. The study of this curious parasite and its habits will at any rate prove interesting and instructive.*

Other parasites.

141. The menhaden seems remarkably free from other parasites, and especially from intestinal worms, not one of which has been met with in numerous dissections. Leeches are occasionally found upon the gills, and there are one or more species of lernæans. Mr. Hance Lawson, of Crisfield, Md., refers to one of these, saying that "there is a five-pronged insect sometimes found on the tail which makes a sore and which we call grappling"—a name doubtless referring to its shape, which might call to mind a grappling-iron; several other correspondents refer to a parasite which is unmistakably a lernæan.

I know of only one described species of crustacean parasitic upon the species, and this is found also upon the alewife. It is the *Lerneonema radiata* (Lesueur) Stp. and Ltk., first described in 1828. It is found figured in the first report of the United States Commissioner of Fisheries, plate VII, Fig. 30, and below, plate X.

26.—PREDACEOUS FOES.

Whales and dolphins.

142. Man, with his instruments for wholesale destruction, takes six or seven hundred millions of these fish annually, but he is only one of its many enemies. Whales follow the schools and consume them in great numbers. Mr. E. B. Phillips states that fin-back and hump-back whales always appear in Massachusetts Bay when the menhaden come. According to Capt. John Grant, keeper of the light-house on Matinicus Rock, Maine, "The whale rises beneath them as they play upon the surface and, with extended jaws, forces himself up through the school with such speed as to project his body half out of water, closing his jaws over large quantities of fish as he falls heavily back."

* This paragraph was written two years before paragraphs 84-91.

Mitchill remarks: "The whalemén say he is the favorite food of the great bone-whale or *Balaena mysticetus*. This creature, opening his mouth amid a school of menhaden, receives into its cavity the amount of some hogsheads of menhaden at a gulp. These pass one by one head foremost down his narrow gullet; and eye-witnesses have assured me that on cutting up whales after death great quantities of menhaden had been discovered thus regularly disposed in the stomach and intestines."*

I have seen fin-back whales apparently feeding in this way at the eastern end of Long Island Sound. Schools of dolphins and porpoises follow the menhaden, consuming them in immense numbers, and seals are said to be among their persecutors.

Mr. Dudley informs me that in 1877 the fish left the sound on the 12th of October; on the 19th enormous quantities were driven back by a school of 30 or 40 whales which the fishermen saw playing off shore.

Sharks.

143. Sharks prey largely upon the menhaden. Capt. B. H. Sisson has seen 100 taken from the stomach of one shark. Mr. D. T. Church gives an account of the destruction of a school off Seaconnet, R. I. "They were lying," he writes, "apparently undisturbed, when a school of sharks appeared among them. The havoc was fearful. One gang of fishermen had their seine in the water at the time, and they completely destroyed it; they were so ugly that they would seize the end of an oar as if it were a fish."

Mr. E. E. Taylor, of Newport, R. I., gives an amusing account of the habits of the thresher shark (*Alopias vulpes*): "The heaviest shark we have around here is the thresher shark; they feed on menhaden. I saw a thresher shark kill with his tail, which was nearly eight feet long, half a bushel of menhaden at one blow, and then he picked them up off the water. They come up tail first, and give about two slams, and it is "good-by, John," to about half a bushel of menhaden."† This story should be taken *cum grano salis*, but still may contain a few grains of truth.

The horned dog-fish (*Squalus americanus*) and the smooth dog-fish (*Mustelus lavris*), the smallest representatives in our waters of the shark family, doubtless do more injury than their larger brethren by reason of their great abundance. The former are so voracious that when they make their appearance all other fishes are driven away. When the dog-fish "strike on," an experienced fisherman always pulls in his lines or his nets and abandons his work.

Other fishes.

144. All the large carnivorous fishes prey on the menhaden. The horse-mackerel or tunny (*Oreochromis thynnus*) is one of the most destruc-

* Trans. N. Y. Lit. and Phil. Soc., 1, 1815, 453.

† Report of Commissioner of Fish and Fisheries, 1871-'72, p. 28.

tive in certain localities. "I have often," writes Mr. George R. Allen, of Brooklin, Me., "observed these pests, with the most imaginable indignation, in their destruction of these fish, and watched their antics from the masthead of my vessel, rushing and thrashing like demons among a school of fish, darting with almost lightning swiftness through them, scattering them in every direction, and throwing hundreds into the air with their tails." This is doubtless the barracoutar spoken of by Maine fishermen.

Boardman and Atkins accuse the pollock (*Pollachius carbonarius*) and the whiting or silver hake (*Merluccius bilinearis*) of much damage done. In reference to the latter they write: "It is known to pursue both herring and menhaden. The former it devours in great numbers, and at Grand Manan a great many of the smaller ones are sometimes caught in the herring-nets. In Bluehill Bay, in Kennebec River, and doubtless in other places, it is caught in the weirs, and the Brooklin fishermen often take it in their seines with menhaden. Its teeth are rather long and remarkably sharp, and they are charged with wounding a good many menhaden which are afterward caught with their sides and backs lacerated as if in that way."*

The striped bass (*Roccus lineatus*) is destructive, and so is the squeeteague or weakfish (*Cynoscion regalis*) and its southern representative, the spotted squeeteague or so-called "sea trout" (*Cynoscion carolinensis*.†) I have found a menhaden a foot in length in the stomach of a squeeteague.

In the southern rivers the gar-fish (*Lepidosteus osseus*), the "trout" (*Micropterus nigricans*), and the cat-fishes (*Siluridae*) with the tarpum, (*Megalops thrissoides*), are said to be its worst enemies. I have found menhaden to be the only thing in the stomachs of specimens of the latter species, taken on the northern coast in summer, and it is probable that these were attracted from their usual haunts in pursuit of their favorite food. The sword-fish (*Xiphias gladius*) destroys many, rushing through the masses of fish, striking right and left with its powerful weapons. From examination of their stomachs it would appear that the bayonet-fish (*Tetrapturus albidus*) also feeds extensively upon them. The codfish is said to eat many of them, and this seems quite probable, for these fish bite freely at a menhaden bait.

The bluefish and the bonito.

145. The bluefish (*Pomatomus saltatrix*) with the bonito (*Pelamys sarda*) are, however, their most destructive enemies, not even excepting man. Mr. Simpson, examining a great many of the bluefish caught on the North Carolina coast in the summer of 1874, found from one to three "fatbacks" in the stomach of each. These corsairs of the sea, not content with what they eat, which is of itself an enormous quantity, rush

* Op. cit., p. 14.

† A southern correspondent speaks of finding eight menhaden in the stomach of one sea trout.

ravenously through the closely crowded schools, cutting and tearing the living fish as they go, and leaving in their wake the mangled fragments. Traces of the carnage remain for weeks in the great "slicks" of oil so commonly seen on smooth water during the summer season.

Menhaden driven ashore.

146. The terrified fish fly in every direction, and are often driven ashore in great numbers. Mr. Church states that the bluefish sometimes come into Massachusetts and Narragansett Bays in such force as to completely exterminate the menhaden, driving them ashore in great numbers.

Mr. James H. Bell, keeper of Mispillion River Light, Delaware Bay, writes that about November 7, 1874, the shores of the bay from Lewes up to Mispillion River were lined with dead fish, bitten to death by the bluefish, or snapping mackerel as it is there called. Many of the dead fish were without tails, and all were more or less mutilated. Many other cases may be mentioned where the fish were thus floated ashore, but whether their death is to be traced to the persecutions of the bluefish or to some epidemic prevailing at the time can never be certainly known.

Mr. David F. Loring, keeper of Highland Light, Truro, Mass., has seen hundreds of barrels of them cumbering the shore in the western part of Provincetown Harbor, driven up by bluefish, and has also seen them thrown ashore in numbers at the mouth of the Merrimac River.

About 1856 they were thrown up on the coast of Maine in such quantities that the people in the vicinity were obliged to bury them as a sanitary measure.

Capt. Joseph Hardy second, light-house keeper at Chatham, Mass., states that in 1832 they drifted ashore on the southeastern point of Cape Cod in such numbers that the inhabitants were summoned to bury them in pits, for fear of a pestilence, and that the same thing occurred a few years later.

Mr. B. Lillingston, of Stratford, states that large numbers are sometimes washed up along the coast of Connecticut in September and October. Mr. F. Lillingston, of the same place, has seen thousands dead upon the shore, some with "a reddish blotched appearance, others eaten as if by cancer." According to Mr. Albert Morris, they floated ashore by tons at Somers Point, New Jersey, in October, 1873.

Mr. Isaac D. Robbins, keeper of Hog Island light station, Maryland, states that in August, 1852, he saw a great many dead ones, about two inches in length, in Swangut Creek, on the Eastern Shore, near the line between Maryland and Virginia. He attributes their death to the effects of the warm weather.

According to Mr. Wallace R. Jennett, they have sometimes drifted ashore on Cape Hatteras in such abundance that the stench of the decomposing mass was almost unendurable.

Capt. David Kemps, of Yellow Bluffs, Fla., writes that about the year 1870 the menhaden in the Saint John's River died in large numbers and were washed ashore upon the banks.

The Newport (R. I.) Daily News of June 13, 1870, states: "Millions of fish, principally menhaden, scup, and young shad, have been driven on to the New Jersey and Long Island shores the past week. Coves, rivers, flats, inlets, and ditches have been so full that farmers have gathered them up by the common pitchforks and shovels, carrying off thousands of cart-loads to manure the land. It is supposed that these schools of small fry were driven inshore by the bluefish."

Mr. Phillips has known them driven by the bluefish up the great rivers of Maine until they died and were washed ashore by thousands.

Captain Spindel on the ravages of the bluefish.

147. Capt. Isaiah Spindel, manager of a fish-pound at the eastern extremity of Buzzard's Bay, states: "I do not think pound-fishing is a quarter as bad as bluefish for destroying fish. A bluefish will destroy a thousand fish in a day. When they get into a school of menhaden you can see a stream of blood as far as you can see. They go into them and they will destroy the whole school before they let them go. I think menhaden are more scarce than they used to be. They put up the guano factory here (at Wood's Holl) on account of menhaden being so plenty then. Twenty five or thirty years ago there were no bluefish, and menhaden were plenty. Only once in a while were there any bluefish there. Finally the bluefish got so plenty they drove all the menhaden out of the bay. There are plenty of menhaden up in the heads of the harbors; some bluefish will go up and drive them up as far as they can, but bluefish don't like to go up into fresh water. Squeteague will swallow menhaden whole. I have seen bluefish and squeteague throw the food out of their stomachs when caught. I think the bluefish fill their stomachs and then empty them just for the fun of the thing, so as to catch more fish. I have seen them go into a school of menhaden and catch some and throw them up again, and then go in again. I could not swear they throw the stuff up, but I am positive that it is so. I have seen the fish all chewed up thrown out in the water. They often bite and swallow a part and leave the rest."*

Professor Baird on the destructiveness of the bluefish.

148. Professor Baird, in his well-known and often-quoted estimates of the amount of food annually consumed by the bluefish,† states that probably ten thousand millions of fish, or twenty-five hundred millions of

* Testimony in regard to the present condition of the fisheries, taken in 1871. <Report of the United States Commissioner of Fish and Fisheries, 1871-72, pp. 68-70.

† Natural History of Important Food-Fishes of the south shore of New England. II.—The Bluefish (*Pomatomus saltatrix*, (Linn.) Gill. Report of United States Commissioner of Fish and Fisheries, 1871-2, p. 241-2.

pounds, daily, or twelve hundred million millions of fish and three hundred thousand millions of pounds annually, are much below the real figures. This estimate is for the period of four months in the middle of the summer and fall, and for the coast of New England only. The calculation allows ten fish, or two and one-half pounds, daily, to each bluefish, and estimates the number of these corsairs of the sea in New England waters at one thousand million. This calculation includes only those fish which exceed three pounds in weight, taking no account of those of a smaller size, which are at least a hundred-fold more numerous, and fully as voracious, and which prey upon the young fish.

Such estimates profess to be nothing more than vague approximations, but are legitimate in their way, enabling us to appreciate more clearly the luxuriance of marine life. The application of similar methods of calculation to the menhaden would be much more difficult. At least one-fourth of the fish devoured by bluefish on the shores of New England are probably menhaden, and as many more are no doubt destroyed by squeteague, bonito, sharks, horse-mackerel, cod, and other predaceous species. The waters of New England wash only one-fourth of the extent of coast upon which the menhaden is abundant, and the estimate of Professor Baird covers only one-fourth of the entire year. Bluefish are abundant for at least half the year as far south as the Carolinas, and commit terrible havoc among the menhaden in the winter months. Farther south they are the favorite food of other species, chief among which are the sea-trout (*Cynoscion carolinensis*). Then there are the schools of porpoises and the whales, which pursue the herded menhaden with wholesale destruction.

An estimate of the annual destruction of menhaden.

149. Is it too much, then, to multiply the three hundred millions of millions of menhaden probably consumed by the full-grown bluefish alone on the coast of New England in the summer months by ten? This would allow three thousand millions of millions of menhaden, old and young, annually destroyed in the waters of the United States, in comparison with which the number annually taken by man is perfectly insignificant. This estimate will seem extravagant at first sight, but I believe that it will be found a very moderate one by any who may take the pains to investigate the question for themselves.

The place of the menhaden in nature.

150. It is not hard to surmise the menhaden's place in nature; swarming our waters in countless myriads, swimming in closely-packed, unwieldy masses, helpless as flocks of sheep, close to the surface and at the mercy of any enemy, destitute of means of defense or offense, their mission is unmistakably to be eaten. In the economy of nature certain orders of terrestrial animals, feeding entirely upon vegetable sub-

stances, seem intended for one purpose—to elaborate simpler materials into the nitrogenous substances necessary for the food of other animals which are wholly or in part carnivorous in their diet. So the menhaden, deriving its own subsistence from otherwise unutilized organic matter, is pre-eminently a meat-producing machine. Man takes from the water annually six or seven hundred millions of these fish, weighing from two hundred and fifty to three hundred thousand tons, but his indebtedness to the menhaden does not end here. When he brings upon his table bluefish, bonitos, weakfish, swordfish, bass, codfish, what is he eating? Usually nothing but menhaden!

27.—MAN AND THE FISHERIES.

Former allusions to the influence of the fisheries.

151. I have remarked above (paragraph 117) that the menhaden appears to be the most abundant species on the eastern coast of the United States, and that there is no evidence of any permanent decrease in its numbers, although from year to year there are fluctuations in their numerical representation.

I have also discussed (paragraph 102) the question of the alleged change in their habits from the tendency of seine-fishing to drive them farther from this coast. Upon this question there can be no decided judgment at present. In paragraph 118, I have spoken of the slight probability of decrease in future.

Future increase or decrease.

152. Whether there is any likelihood that the myriads which now swarm our waters will ever be perceptibly diminished by the loss of six or seven hundred millions of their number annually I will not presume to say. I simply call attention to the fact that spawning fish are apparently never taken in the nets. It is the opinion of many authorities that if fish are not interfered with at the time when they are reproducing their kind there is no great probability of decreasing their number.

Alleged destruction of the fisheries.

153. The Commissioners of Fisheries of the State of New York, Messrs. Horatio Seymour, Edward M. Smith, and Robert B. Roosevelt, in their report for the year 1874* (p. 31), speaking of the depletion of the waters of Great South Bay, remark:

“Last season was favorable for the pound-fishermen, in the circumstance that the sharks did not destroy their nets. The result was, that there was absolutely no fishing inside the bay the entire summer. Usually, by the month of August, they have to move from the inlet to

* Report | of the | Commissioners of Fisheries | of the | State of New York. | — | Transmitted to the legislature, February 1, 1875. | — | Albany: | Weed, Parsons and Company, Printers. | 1875. | 8vo. pp. 61.

safer quarters, and the weakfish get in sufficiently to furnish fair fishing, and to promise a continuance of the supply. But that year the pounds remained undisturbed, and not even the weakfish could find an entrance. Formerly moss-bunkers, or bonyfish which are manufactured into oil and manure, frequented the bay and brought bluefish after them. They are the favorite food of the latter. They have been the foundation for quite a business in that part of our State, a number of factories having been established along the shore. Now they are never taken inside the bay, and the bluefish, whether for the reason that their food is wanted, or on account of their natural shyness, are also rarely seen inside. The latter are still caught in seines at some of the inlets, but seem to be stopped by the pound-nets, or else return of their own accord to the ocean. They do not enter the pound-nets, being seldom taken in them. This would go to show that they are frightened away; that when they meet the wings of the net they do not attempt to pass around it, but simply retrace their steps to safer quarters. The loss thus inflicted on the residents along the bay, without benefit to any one, is incalculable."

Comments upon these allegations.

154. It is the commonly received opinion that purse-net fishing is destined eventually to destroy all the menhaden in our waters. Many decided views to this effect have been advanced by correspondents. All that can be said at present is that the commonly received opinion has not yet been proved to be true. The same may be said regarding pound-net fishing. It is doubtless true that the fisheries in a given locality may deplete the waters of the immediate region in which they are prosecuted. The cod and halibut may be fished for upon a single bank until the local supply is exhausted. This depletion does not, however, necessarily affect the aggregate numbers upon the entire coast.

The barrier of pounds will doubtless prevent the menhaden from entering a body of water like the Great South Bay, but this does not necessarily have any effect upon the aggregate representation of the species in the coast waters. The small number of fish consumed by man proportionately to the number consumed by other fishes has been alluded to.

A writer in Chambers's Journal estimates the herring-eating power of the Solan goose as follows: "Say that the island of St. Kilda has a population of 200,000 of these birds, and they feed there for seven months; let us also suppose that each bird, or its young ones, eat only five herrings per diem; that gives a sum total of one million of these fish, and counting the days in the seven months from March to September as 214, that figure may be taken to represent in millions the quantity of herrings annually devoured by these birds. It has been calculated that the cod and ling in the seas and friths around Scotland would devour more herrings than could be caught by 50,000 fishermen. We have examined the internal economy of a codfish, which contained in its stomach no less than eleven full grown herrings."

Professor Hind's unwarranted statements.

155. A voice of warning comes to us from the provinces. Professor Hind writes: "It is not the fishermen alone who diminish the value of the waters of the United States as food producers, it is the agriculturist, the manufacturer, and the lumberer. If the supplies directly or indirectly afforded by British-American coastal fisheries were suddenly annihilated, the effect of the inquiries instituted under the direction of the United States Commissioner of Fish and Fisheries would be at once diverted against the fish-oil and fish-guano manufacturers as well as the lumbering and other interests, which have so diminished the anadromous species and destroyed the cod-fisheries on the New England coast. What with the ravages of the bluefish and the demands of the industrial interests named, the drain upon the United States waters is far beyond the natural resources of the limited area in which the cod, the hake, the halibut, and other deep-sea fish are sought. Hence recourse must be had to British-American waters or the open sea remote from the coast of the United States, and bait must be obtained to secure remunerative fares. Without this bait the fishery would be commercially impossible; with it, it becomes not only remunerative, but permits those special fisheries which have fish-oil and fish-guano as their object to go on without that legislative interference which would otherwise be invoked by a powerful interest contemplating impending ruin and discerning its cause."*

Comment is unnecessary. The facts above stated alone are a sufficient commentary.

Protective legislation in Maine.

156. As this memoir goes to press, the question of legislative restrictions of the menhaden fisheries is being agitated in Maine. One of the valuable results of this discussion has been the publication of Mr. Maddock's report upon "The Menhaden Fishery of Maine," which is intended to counteract the statements of the advocates of more stringent laws. The proposed law is intended to prohibit fishing with seines in waters within three miles of the shore. Mr. Maddock's remarks, quoted below, seem very sensible and temperate, and I am prepared to indorse them:

"In fact, where all the data point to the conclusion that the menhaden while on our coast are being destroyed by predaceous enemies in greater numbers every day than by man with all his appliances in a whole season, it would seem sheer unreason to establish a petty restriction of the catch lest the stock should be ultimately exhausted.

"No other State will be guilty of such folly, even if we should allow our own to be. The effect of restricting the fishery, as referred to, would be to drive the oil and guano manufacture and those engaged in it out of the State, with all their capital and equipment, and to extinguish the industrial activities set in operation by their business. The time for

*HIND, *op. cit.*, p. 142.

restriction will be when restriction has been shown to be needed. Other States have made a trial of the interference policy in this same matter and have abandoned it as uncalled for and unwise.

"The complaint that the seines 'scare' the edible fish from the interior waters may be dismissed as too trivial for notice. If the limited operations of seining inshore scare the fish out, much more should the far more extended operations outside scare them in. The same weight is to be attached to the charge that the seines injure the shad fishery by capturing the fish. The total number of shad caught by all the members of the Oil and Guano Association combined does not amount to over two hundred barrels per year. Salmon are never caught in their seines."

I.—THE MENHADEN FISHERIES.

28.—THE FISHING GROUNDS.

The location of the fishing grounds.

157. As has been already indicated in the description of the migrations and movements of the menhaden, there are certain portions of the coast which they frequent more certainly and constantly. These are marked upon the map accompanying this memoir and may be designated as (1) the Booth Bay Region, (2) the Cape Ann Region, (3) the Cape Cod Region, (4) the Narragansett Bay Region, (5) the Long Island Sound Region, (7) the Sandy Hook Region, (8) the Chesapeake Region, and (9) the Hatteras Region.*

Bearing in mind the fact that the menhaden is fond of shallow, brackish waters while the mackerel is not, it is quite curious to remark that their favorite haunts are much the same. Both species are caught most successfully in the great, partially-protected indentations of the coast. Whether it is on account of the calm waters, the abundance of food, or the detention of the schools in these great "pockets," as they may be called, is not apparent. Perhaps all have their influence, probably the latter has the greatest.

In these localities, at different seasons of the year, the fisheries can be most successfully carried on, and here only can they be made profitable.

29.—METHODS OF CAPTURE.

Past and present methods contrasted.

158. Twenty years, ago when the menhaden fisheries were of very small importance, the business of manufacturing oil and guano being still in its infancy the only use for the fish was as a fertilizer in its raw state. This demand was easily supplied by the use of seines and gill-nets along the shore, for at that time the habits of the fish were probably very different. They swarmed our bays and inlets, and there is quite good authority for the story that 1,300,000 were once taken with

* Plate XI.

one haul of the seine in New Haven Harbor.* Constant fishing on the northern coast has driven the menhaden out to sea, though in the south their habits are much the same as of old. In New England the menhaden fishery has become to a considerable extent sea-fishing, and is prosecuted on the grandest scale.

Estimates of numbers of vessels and fishermen by collectors of customs.

159. Under the statistics of manufacture will be found the statements of the manufacturers in reference to the number of vessels and men employed by them. It may not be out of place here to give a corresponding estimate on the part of the collectors of customs and others in connection with a general statement of the location and methods of the fisheries. The manufacturers' enumeration excludes the vessels engaged in catching the menhaden for bait, but is, as far as it goes, probably more nearly correct than any other, the laws of registration being so lax that many fishing-vessels do not appear upon the custom-house books.

Fisheries of Maine.

160. Mr. William H. Sargent estimates for the district of Castine, Me., about 20 decked vessels and 150 open boats. The vessels range from 15 to 80 tons. The number of men employed (probably including the factory hands) is about 425.

For the district of Belfast, Mr. Marshall Davis estimated in 1873 about 25 vessels with 125 men. In 1877, according to the same authority, there were about 100 boats owned by line fishermen, each of which uses from three to six gill-nets.

Mr. Benjamin F. Brightman, collector of customs at Waldoborough, Me., gives 54 gangs of 10 to 12 men each. This district includes the region between the Penobscot and Kennebec Rivers, where all the large factories are located. The vessels in this region are steamers, schooners, and sloops of from 20 to 100 tons. This estimate is for 1873 and reference to the report of the Maine Menhaden Oil and Guano Association for the same year shows that these gangs include 55 vessels, 17 of which were steamers and 533 men. The number of men for 1874 is 551. More than half of these gangs are fitted out in Rhode Island.

For the town of Booth Bay, in this district, Mr. G. B. Kenniston estimates 21 gangs and 210 men.

Mr. J. Washburn, jr., collector of the Portland, Me., district, gives an aggregate of 110 vessels with 500 men, but this estimate evidently includes parts of other districts.

* Mr. Arthur T. Neale, of the Connecticut Agricultural Experiment Station, tells me that he has talked with one of the fishermen concerned in this famous haul. There was no accurate account of the numbers and the catch was variously estimated at from 1,000,000 to 1,300,000. Numerous carts were employed for three days in carrying the fish from the shore and finally a large part of the fish were allowed to escape.

Fisheries of Massachusetts.

161. Mr. F. T. Babson, of Gloucester, Mass., states that in his district are 40 vessels employing 400 men and a capital of \$200,000. In this enumeration are included at least four steamers belonging to Judson Tarr & Co., of Rockport, which are used for their factory in Bristol, Me., and perhaps others. The remaining vessels are schooners of from 20 to 70 tons, which are wholly engaged in taking fish for bait. Fisheries of some importance are carried on at the mouth of the Merrimack River. They are described under the section relating to boats.

Mr. Simeon Dodge, of Marblehead, Mass., reports "no large vessels employed" in his district, though small boats fish for menhaden to be used for bait, and Mr. E. B. Phillips makes the same report for the vicinity of Swampscott.

Mr. Thomas Loring, Plymouth, Mass., says that in his district no vessels are wholly employed in this business; a few menhaden are caught for bait in gill-nets.

Capt. Hermann S. Dill, of Billingsgate Island, writes that for about three weeks, in the fall when menhaden are fat, 12 or 15 men and one or two small vessels are employed in catching them in Wellfleet Bay. A few are caught from dories.

About the extremity of Cape Cod very slight attention is paid to the menhaden. Capt. David F. Loring, keeper of Highland Light, North Lynn, Mass., writes under date February 23, 1875: "I believe the fishermen in this vicinity have an idea of going into the business quite extensively the coming season." He probably refers to the business of catching the fish for bait, which would naturally prove very profitable in the neighborhood of a great fishing center like Provincetown.

At Chatham, on the heel of Cape Cod, according to Capt. Josiah Hardy, 2d, in Chatham Bay, there are 13 weirs, but no vessels are employed in taking the menhaden.

From Nantucket, Mass., Mr. Reuben C. Kenney, collector of customs, reports that sail-boats of 5 tons burden are employed in setting the gill-nets, of the proceeds of which about half is used for bait, the other half sent to factories upon the mainland.

In the vicinity of Hyannis, Mr. Alonzo F. Lothrop, keeper of the light, states there are no menhaden fisheries.

Edgartown, Mass., and the Island of Martha's Vineyard employ no vessels in this fishery. Mr. C. B. Marchant, collector, writes that large numbers are taken in the pounds, and are sold for bait.

Fisheries of Rhode Island.

162. In Narragansett Bay, according to Mr. Church, about 10 gangs and 100 men are employed. Nearly 30 gangs fit out for the fisheries in Maine, and these usually seine Narragansett Bay for a short time, spring and fall.

No vessels are engaged in the menhaden fisheries at New Shoreham, R. I. (Block Island), nor in the vicinity of Point Judith.

Fisheries of Connecticut.

163. In the vicinity of Fisher's Island Sound, according to Capt. William H. Potter, of Mystic, Conn., there are employed 14 large boats and 36 small, and about 240 fishermen. There are 14 gangs working between the Thames River and Stonington, Conn.

Between the Thames and the Connecticut, Capt. S. G. Beebe states that there are 8 sloops of about 20 tons, each carrying about 10 men. Luce Bros., of East Lynne, have 1 steamer, 9 sloops, 48 fishermen, and 40 factory hands.

Mr. R. E. Ingham, of Saybrook, Conn., thinks that between Saybrook and New Haven there are employed about 14 vessels and 80 men, but this estimate is undoubtedly too great.

In Western Connecticut, according to Mr. G. W. Miles, there are employed 7 gangs, with 21 sloops and 230 men. Mr. F. Lillingston, of Stratford, puts the figures at 30 sloops and 300 men.

Fisheries of New York.

164. For the Eastern District of Long Island, Mr. W. S. Havens estimates 60 vessels and 540 men. Captain Sisson, for 1873, put it at 105 vessels and 400 men; in this estimate he probably includes the lighter boats.

Hawkins Brothers, of Jamesport, N. Y., employ 110 men, 50 of whom are factory workmen.

The Sterling Company, of Greenport, N. Y., employ 3 gangs, consisting each of 8 men, 2 boys, and a cook, working from 3 yachts and 6 lighters.

Mr. Joseph D. Parsons, writing from Springs, Suffolk County, New York, December 10, 1877, states that in that vicinity 43 vessels and 175 men are employed in the menhaden fishery.

At the entrance to New York Bay and off Sandy Hook the fish are taken for the sardine factories, small sail-boats of about 10 tons being used.

Fisheries of New Jersey, Delaware, and Maryland.

165. In the vicinity of Little and Great Egg Harbor, New Jersey, Mr. A. G. Wolf, keeper of Absecum light-house, states that there are 10 vessels and 40 men employed; this includes the gill-net boats of 4 and 5 tons, sloops, schooners, and one steamer of about 15 tons. This perhaps includes the Somers Point Oil Works, where, according to Mr. Albert Morris, there is a gang of 9 men with 3 vessels.

In Delaware Bay there are no menhaden fisheries, though many of these fish are taken in seining for other kinds.

In Chesapeake Bay no effort is made to take them in quantity except

in Tangier and Pocomoke Sounds, where, according to Mr. Hance Lawson, of Crisfield, Md., there are employed 5 vessels averaging about 15 tons each and 5 oared barges. Small numbers are taken in gill and trap nets at other points.

Fisheries of Virginia and North Carolina.

166. In the inlets of North Carolina no menhaden are taken in quantity.

The Quinnipiac Fertilizer Company, of New Haven, inaugurated menhaden fishing in North Carolina and Virginia in 1866. Their prospecting party passed the winter in Roanoke Sound and established weirs for the capture of menhaden, which were there very abundant. They were, however, driven away by the natives, whose jealousy of strange fishermen led them to tear up their weirs. They then located themselves near Cape Charles. Four companies established factories here—one from Maine, one from Long Island, and two from New London. They found the fishery very good, although the fish produced little oil, and were only adapted for the manufacture of fertilizers. The laws of Virginia do not encourage the inauguration of such enterprises by strangers, and the following year it was thought unadvisable to continue the business.

Since 1872 several stock companies have been organized, under Virginia laws, for the purpose of carrying on the menhaden fisheries in the Chesapeake, and their success is well assured. Although the oil is not produced in great quantities, there is sufficient to pay the cost of manufacture, thus leaving a clear profit in the scraps.

Fisheries in the South.

167. At Cape Hatteras and in the five adjacent townships there are, according to Mr. Simpson, 200 boats and about 500 men. None of these, however, make a special effort to capture the menhaden.

In the rivers near Beaufort, N. C., they are taken in small quantities in gill-nets worked from open boats and canoes.

South of Beaufort, N. C., the menhaden has no statistical importance. They are sometimes caught incidentally in the shad and mullet nets of the Saint John's River, Florida, but, as in the Potomac, they are considered by the fishermen to be useless annoyances.

30.—APPARATUS OF CAPTURE.

The purse-seine.

168. The purse-seine is doubtless more effective than any other fishing apparatus ever devised. By its use a school of almost any size may be secured without the loss of a single fish. The enormous demands of the oil factories can be met only by fisheries conducted on the grandest scale, and the purse-seine is used by the factory fleets to the exclusion

of all other nets. In the vicinity of Gloucester, where menhaden are caught for bait, the purse-seine is also used. It need only be said that it is an immense net, which when in use is a flexible wall of twine, suspended by its upper edge, extending from 90 to 180 feet below the surface, and from 800 to 1,500 feet long. This wall is made to encircle the fish and then its lower edge is gathered up by a rope passing through rings prepared for the purpose. The seine when pursed becomes essentially a huge dip-net, from which the fish may be taken at the pleasure of their captors.

The purse-seine is said to have been invented about the year 1837 by a native of Maine, who had been for some years employed as a hand on a Gloucester fishing-smack. He conceived the idea of capturing mackerel in large numbers, and invented a seine which is substantially the same as that now in use. Finding the Gloucester fishermen unwilling to experiment with his new apparatus, he carried it to Rhode Island, where it was first put into use in the vicinity of Seaconnet for seining menhaden.

The first seine used north of Cape Cod was introduced in the year 1850 by Capt. Nathaniel Adams, of Gloucester, in the schooner "Splendid." Capt. Nathaniel Watson, of the "Raphael," began using one the same year.*

The early seines were about 200 yards in length, 22 fathoms in depth, and of 2.5 inch mesh, there being about 350 meshes in the bunt of the seine. The twine used was much heavier than that used in the present seines, and the whole net weighed six or seven hundred pounds. The present seine, however, did not come into general use, as I am informed by Mr. Marchant, of Gloucester, until about 1860.

During the last eight years there has been greater change in their size than during the ten years previous. In 1869 the nets were 160 fathoms in length, 700 meshes deep, the meshes being $2\frac{1}{4}$ inches, and would weigh about 400 pounds, being made of No. 9 twine (Hadley 29).

Fishing in deeper water began in the years from 1869 to 1872; and since that time a gradual increase has taken place in the size of the nets corresponding to that which has already been described in the case of the seine-boats. The popular size for seines in 1877 is 200 fathoms in length, 1,000 meshes deep, the mesh being 2 and $2\frac{1}{2}$ inches, those in the bunt being sometimes finer, the twine heavier. They are made of No. 6 twine (Hadley 16), and weigh about 700 pounds. The largest one known to Captain Marchant is 247 fathoms long, and weighs about 1,000 pounds.

In order to understand the method of working a purse-seine, it is necessary that the manner of "hanging it" should be described. At the top of the net is the cork-line, upon which corks are placed at distances apart of from 12 to 15 inches; two corks are usually put together (which are designated in trade as numbers 2 or 3), and are 4 inches in

* Mr. Maddocks states that the first purse-seine was used on Chelsea Beach.

diameter. There is no lead-line, properly speaking, though light weights are placed upon the bottom line of the seine, near the ends, about 2 ounces in weight, about 60 pounds in all, four inches apart at the sides, and farther apart near the middle. Sometimes twelve rings are strung close together so that they touch. The rings through which the pursing rope passes are almost heavy enough to render other weights unnecessary. The lower edge of the seine is hung on six-thread manilla rope; to this is attached a series of so-called bridles, these bridles being 3 fathoms in length and placed 3 fathoms apart. Upon each of these bridles slides an iron ring weighing $1\frac{1}{2}$ to $2\frac{1}{4}$ pounds and $3\frac{1}{4}$ inches in diameter; through these rings runs the purse-line. The average weight thus placed upon the bottom of the mackerel-seine is about 220 pounds; this, however, includes special leads put on at the ends of the seine, 55 to 80 pounds of lead being thus distributed in leads of one-eighth to one-quarter to one-sixth of a pound in weight. Upon the menhaden-seine about 35 pounds of lead is considered sufficient. In operating this seine a large heavy weight, called by the fishermen of Gloucester a purse-weight, by those of Southern New England "Long Tom," is used, which is placed upon the vertical ropes at the end of the seine by the use of snatch-blocks, and is allowed to run down to the bottom of these ropes, thus fastening securely together the ends of the so-called lead-line before the operation of pursing begins. The mackerel-seine is usually arranged so that when it is pursed there are large triangular flaps of netting hanging at the end and closing the opening. This is accomplished by allowing the purse-lines to pass obliquely from the last purse-rings, which are placed at the distance of about six feet from the ends of the lead-line. In mackerel-seining these are not, by all fishermen, considered necessary, as the mackerel do not, like the menhaden, strike for the bottom of the net when they find themselves inclosed. This weight weighs from 60 to 120 pounds, and varies somewhat in shape; the usual form is figured in plate XIV. Some seiners now use two smaller weights, one upon each line. The best fishermen prefer to use the weight, and by this method the largest fares of fish are taken.

The seines used by the menhaden vessels are smaller than mackerel seines, although the latter are frequently used in this fishery, especially near Gloucester.

From the letters of our correspondents it appears that the length of menhaden seines varies from 100 to 300 fathoms, and their depth from 10 to 25 fathoms. Some seines, 50 fathoms long and 5 fathoms deep, are mentioned, but these must have been exceptionally small.

In early days, it is said, a mesh of $4\frac{1}{4}$ inches was used. In 1873 Maine fishermen preferred a mesh of $3\frac{1}{4}$ inches. From 1875 to 1877 a still smaller mesh was employed. The seines now in use in Connecticut have a mesh of $2\frac{1}{2}$ inches (that is, $1\frac{1}{4}$ inches square, or $1\frac{1}{4}$ "bar"); they are 130 fathoms long when "hung," or 200 fathoms "straight twine" or stretched as they leave the factory, and 15 fathoms deep. They are made

of small cotton twine (No. 20 to No. 12 thread), except in the middle, or "bunt," which is knit of stronger twine (No. 14 to No. 9 thread), to hold the fish when they are gathered into a small compass. They weigh 600 or 700 pounds, and cost not far from \$1,000 when ready for use. On the coast of Maine they are larger, being commonly from 225 to 275 fathoms long and 20 fathoms deep in the middle, tapering to 14 fathoms at each end.*

The American Net and Twine Company supplies the Maine fishermen with seines usually 250 fathoms long and 20 or 25 fathoms deep, those of Southern New England and New York with shorter ones, usually 150 fathoms long and 15 to 20 fathoms deep.

The steamers of the Pemaquid Oil Company carry each two seines; a long one and a short one. The long seines are about 9,500 meshes long and 650 meshes deep (size of mesh $3\frac{1}{2}$ inches), and when rigged are from 280 to 300 fathoms long, and 15 to 17 fathoms deep. The shallow-water seines are from 7,000 to 7,500 meshes long and 500 to 550 meshes deep (size of mesh $2\frac{1}{2}$ inches), and when rigged are from 170 to 180 fathoms long, and 8 to 10 fathoms deep. Each steamer employs from 12 to 15 men, including captain, mate, engineer, fireman, cook, and sharesmen, and is supplied with two large working boats from 22 to 82 feet long, as well as two small boats,—“drive boats,”—which are rowed by the men who drive the fish into the seine.

The three sloops of Gurdon S. Allyn & Co. carry seines 200 fathoms long and 580 meshes ($2\frac{1}{2}$ -inch mesh) deep.

Gallup & Holmes use seines of 3-inch mesh, 9,200 meshes in length and 600 meshes deep, with shallower seines for shoal water.

The three steamers of E. T. De Blois carry seines 300 fathoms long and 17 fathoms deep.

The two sloop-yachts of William T. Fithian & Co., Napeague, N. Y., carry seines about 160 fathoms long and 15 fathoms deep.

The three sloop-yachts and two steamers of Hawkins Brothers, Jamesport, N. Y., carry seines from 100 to 130 fathoms in length and of $2\frac{1}{2}$ -inch mesh.

Luce Brothers, of East Lyme, Conn., use seines 150 fathoms long and 18 fathoms deep.

The seines used by the Sterling Company of Greenport, N. Y., are 125 to 150 fathoms long and 80 to 100 feet deep.

The seine-boats.

169. The boats used by the Gloucester fleet in the purse-seine fishery are built after a peculiar model and solely for this purpose. The present form of the seine-boat was devised, about the year 1857, by Messrs. Higgins & Gifford, boat-builders, Gloucester, Mass. The seines had previously been set from square-sterned lap-streak boats, about 28 feet in length, and resembling in shape an ordinary ship's yawl.

* Boardman and Atkins, *op. cit.*, p. 23.

The seine-boat as now in use resembles the well-known whale-boat, differing from it, however, in some important particulars.

The seine-boat, according to Mr. Gifford, must have three qualities: (1.) It should tow well; consequently it is made sharpest forward; a whale-boat, on the other hand, is sharpest aft, to facilitate backing after the whale has been struck. (2.) It should row well, and this quality also is obtained by the sharp bow; the whale-boat also should row well, but in this case it has been found desirable to sacrifice speed in part to the additional safety attained by having the stern sharper than the bow. (3.) It should be stiff or steady in the water, since the operation of shooting the seine necessitates much moving about in the boat.

The Gloucester seine-boat of the present day is a modification of the old-fashioned whale-boat, combining the qualities mentioned above. The average length of such a boat is about 34 feet, its width 7 feet 5 inches, its depth amidship 33 inches. At the stern is a platform, measuring about 4 feet, fore and aft, on which the captain stands to steer: this is 6 to 8 inches below the gunwale. Another platform extends the whole length of the boat's bottom, from the after part of which the seine is set. In the bow is still another platform, on which stands the man who hauls the cork-line. There are four thwarts or seats, a large space being left clear behind the middle of the boat for the stowage of the seines. Upon the starboard side of the boat, near the middle, is arranged an upright iron support, about 18 inches in height, to which are attached two iron snatch-blocks used in the working of the purse ropes. Upon the opposite side of the boat, generally near the bow and stern, but with position varied according to the fancies of the fisherman, are fixed in the gunwale two staples, to which are attached other snatch-blocks used to secure additional purchase upon the purse-ropes. In the center of the platform at the stern of the boat is placed a large wooden pump, used to draw out the water which accumulates in large quantities during the hauling of the seine. The steering rowlocks, with the peculiar attachment for the tow rope and the metallic fixtures described above, are manufactured especially for seine-boats by Messrs. Wilcox & Crittenden, Middletown, Conn.*

Until 1872 the seine-boats were always built in the lap-streak style; since that time an improved form of smooth-bottomed boats, built with battened seam set-work, sheathed inside with pine, and with oak frame and pine platform, has been growing in popularity. The advantages claimed for this boat by the builders are: (1.) Increased speed; (2.) greater durability, on account of the more solid character of the wood-work and tighter seams; and, (3.) less liability to catch the twine of the nets by reason of the smooth sides. It is not so stiff as a lap-streaked boat of same width, but in other respects superior.

Since the general adoption of the purse-seine, in the menhaden and mackerel fisheries, an account of which is given elsewhere, there has

* The Cape Ann seine-boat, with all its attachments, is illustrated in Plate XV.

been a gradual increase from year to year in the size of the seine-boats, keeping pace with a corresponding increase in the size of the seines.

In 1857 all boats were 28 feet in length. In 1872 the length had increased to 30 feet, and in the summer and fall of the same year an additional foot was added to the length. In 1873 almost all boats which were built had a length of 31 feet; a few of 32 and 33. In 1874 almost all were 33 feet, as they were during 1875 and 1876, although some were made 35 and 36 feet. In 1877, 34 feet is the most popular length, though one or two 38-foot boats have been built. Seven, eight, or nine oars, usually 13 or 14 feet in length, are used in these boats, besides a steering-oar of 16 or 17 feet.

These boats last, with ordinary usage, six or seven years. At the close of the fishing season they are always taken ashore and laid up for the winter, in a shed or under trees, and are completely refitted at the beginning of another season.

The seine-boats, carried by the "menhaden catchers" south of Cape Cod and by all the steamers, are shaped like ships' yawls, square-sterned, smooth-bottomed, and battën-seamed, 22 to 26 feet long and $6\frac{1}{2}$ feet beam; they are built at New Bedford, New London, Greenport, and at Mystic River, and cost about \$125 each, the finest \$185. The New Bedford boats are preferred by many fishermen.

When boats of this model are used every gang has two, each carrying three men and half of the seine; this arrangement leaves one of the crew upon the sloop and two in the lighter. On the coast of Maine, a man is usually sent out in a dory to drive the fish.

The Cape Ann fishermen stow their seines in one boat, and in shooting the seine one end of it is carried in a dory.

The Cape Ann dory is 15 feet long on the bottom, 19 on top, 5 feet 2 inches beam amidships, 21.5 inches deep, 36 inches high at the stem, 34 inches at the stern, 2 feet 10 inches wide at bottom of stern. These dories are built with considerable difference in their "sheer," those used on the shore having a straighter bottom than those used in the Bank fisheries. The boats used on the seine fisheries are generally of an intermediate form.

Messrs. Higgins & Gifford manufacture an improved pattern of dory (patented January 2, 1877), for which they claim the same advantages already mentioned under the description of the seine-boat. They are built of pine, with oak-timber gunwales, stem and stern. There are four boards upon each side fastened in battened set-work. The gunwales are whole instead of being bent and capped. They have no projecting stem-head, in this respect also differing from the old form.*

The sailing-vessels and steamers.

170. Small schooners and sloops were used in the early stage of the business, these succeeded by larger, and these to a great extent by

* The Cape Ann dory is illustrated in Plate XVI, fig. 1.

steamers, of which there are now about sixty, each from 60 to 150 feet in length, and costing from \$7,000 to \$40,000. The advantages of steam are too obvious to need special notice, such as dispatch, economy of time and labor, etc. With the advent of steam-vessels, larger factories with more ample equipment become a necessity in order to utilize the augmented supply. The first factory had the capacity to work up 500 barrels per day. The larger factories can now take 3,000 to 4,000 barrels daily. At the outset 4,000 barrels per steamer was a large catch to each fishing "gang." Now the average catch per steamer is 10,000 barrels, and 20,000 barrels are not unprecedented.* The Pemaquid Oil Company employs several vessels in shipping oil, and in carrying the dried scrap to England.†

Description of steamers.

171. The average burden of the menhaden-steamers is about 60 tons. They are built of hard pine, with white-oak frames, with a water-tight tank in the middle in which the fish are stowed. This tank is said to make the vessels exceedingly safe, enabling them to float when their planking is badly injured. The steamer "Jemima Boomer," owned by Joseph Church & Co., while at sea in rough weather had 50 feet of her keel knocked out, together with eleven of the bottom planks. She was taken upon a marine dock without sinking. Each steamer carries from twelve to fifteen men, who live in the forecastle.‡

Mr. George Devoll, of Fall River, Mass., describes his steamer, the "Chance Shot." It is 39 tons in burden, 68 feet long, and 18 feet wide, and 5 feet in depth of hold. Its carrying capacity is about 700 barrels of fish. The consumption of coal is about one ton daily. The cost of running is about \$8 per day, including coal, oil, and the wages of the engineer. The crew are employed on shares, each man paying his own board and running his chance. The boat and seine draw one-half of the profits, and the gang half—the gang paying provision-bills and cook's wages. There are seven men in the gang besides the cook and the engineer.

A model of the fishing steamer "Leonard Brightman," owned by Joseph Church & Co., of Round Pond, Me., was exhibited in the United States Government building in Philadelphia and is now deposited in the National Museum. The steamer "Seven Brothers," also owned by Joseph Church & Co., was the first steamer built for and used in this fishery.

31.—CERTAIN REQUIREMENTS OF PURSE-SEINE FISHING.

Methods of handling the net.

172. Much care and expedition are necessary in handling a purse-seine full of fish. In the event of a very large draught, if the fish are

* Maddock's Menhaden Fishery of Maine, p. 15.

† Appendix I, contains a partial list of vessels employed in the menhaden fishery.

‡ Plates XVII and XVIII show the menhaden-steamer and its plan of arrangement.

left in the net too long they are killed by the confinement and close pressure, and sink. In such a case the only alternative offered the fishermen is to cut open their seine. Sometimes the dead fish carry the net with them to the bottom. When there are more than enough fish in the seine to fill the vessel to which it belongs, and there is danger that they may be lost, other vessels which are near often take the surplus fish. In such a case, writes Mr. Babson, one-half the value of the fish is paid to the captors.

In calm or moderate weather, fishing is carried on from dawn till dark, though morning and evening seem most favorable. In rough weather the nets are not easily set, while the fish usually swim farther from the surface and cannot be seen. Cold northerly and easterly winds seem to affect the fish, causing them to sink toward the bottom. Southerly winds seem the most propitious.

Mr. Dudley states that in the fall, during the southward migration, the fish play at the surface with a northwest wind.

The best time for seining.

173. The early morning is apt to be the stillest part of the day, and a large part of the fish are taken at that time.

So far as I can learn, the motions of the fish are not particularly affected by the tides, except that, like other *Clupeidae*, they prefer to swim *against* strong tides and winds. An impression seems to hold among the fishermen that rather better success attends fishing on the flood-tide. This is no doubt the case where gill-nets are in use, for in localities where the fish have not been frightened off shore by constant fishing they like to play up into coves and bays with the rising tide, and are then easily taken by the gill-nets and the pounds or weirs.

Where the purse-seines are worked in deep water off the shore, as on the coast of Maine, little attention need be paid to the tides; but where they are used in bays or channels where the tide has much head, there is a practical difficulty in using them except at or near the time of slack water. In a swift current the seine is liable to accidents from being caught on rocks or other obstructions, or may be capsized or pulled out of position. In Narragansett Bay, the difficulties of this kind appear to be particularly great. According to Mr. Church it is not uncommon for a gang to work all day without success, their net being capsized every time it is set.

32.—DESCRIPTIONS OF FISHING SCENES.

Menhaden fishing in Southern New England.

174. The first time the writer ever saw menhaden-fishing was in August, 1874, when cruising off Watch Hill, Rhode Island, in the Fish Commission yacht "Cygnet." Several trim-built sloops are beating off and on, within a mile of the rocks. That they are "bony-fish catchers"

is evident from the two long boats which are towed astern, carrying the purse-seine, which looks like a bale of brown hay stowed in the middle of each boat. A man stands at every mast-head watching for the well-known ripple. A school passes under the bows of our yacht and rises to the surface at a short distance, the bright sides of the fishes glistening in the sun and their tails flipping the surface noisily. The sharp eyes of the "lookout" of the nearest vessel soon detects their presence. The sloop comes about and sails to the leeward of the school. As soon as they are near, three men jump into each boat. Two man the oars, a third stands in the stern and pays out the net, while the boats, rapidly diverging, are rowed around the fish, each describing a semicircular course. Now their courses converge and the men row faster. They come together and pass, thus closing the circle of network. The men all jump into one boat, the purse-weight, or "long Tom," as they call it, is hooked to the two lead lines, and a splash of water announces that it has been thrown overboard to slide down the ropes and draw the lower ends of the net together. Now they begin hauling at the bottom lines, and in ten minutes they have drawn the bottom of the net into a purse and the fish are secured. The "lighter," or transporting boat, now sails up. The men on board heave a line to the seine-boats and they are brought alongside. A large dip-net, three feet in diameter, is now suspended by a block and tackle in the rigging of the lighter, and the fish are rapidly transferred from the seine to its hold. The silvery masses of fish are hoisted into the air and dropped into the vessel, settling in the bins with a flapping noise like the sound of distant thunder or the hand-clapping of a large audience.

In August, 1876, when on the steamer from Saybrook to Greenport, I saw a fleet of sixty vessels busily plying their nets in the sound near the mouth of the Connecticut. In the evening a gale sprang up from the southwest, and as the steamer entered Peconic Bay the little sloops were seen scudding to harbor under low-reefed sails. Every wave swept the decks, but they floated like sea-birds. Some of them were loaded to the rail with fares of fish.

Menhaden fishing about Cape Ann.

175. We are indebted to Captain Babson for facts about the fisheries at Cape Ann, which are carried on for the purpose of securing bait for the codfish and mackerel fleets. Vessels for this business are fitted out from the port of Gloucester on the same basis as those for other fisheries. The owners furnish the vessel-outfits, seine and boats, the crew going "on the halves"; that is, taking for their share half of the entire "catch" while the other half is claimed by the owners. A good vessel with boats costs about \$5,000. A seine costs about \$1,000, and with fair usage lasts through two seasons; it is made of cotton twine and preserved by the use of salt and tar. The seine is carried on a small deck at the stern of the seine-boat, which is about 30 feet long and 8 feet

wide and is built on the plan of a whale-boat of the old style. Only one seine-boat is used here, and on this the whole seine is carried, one end of the seine being taken by a "dory" with two oarsmen.

The Cape Ann Advertiser reported in 1872 that the menhaden fishery was prosecuted by about 40 vessels from that port.

Mr. Frederic G. Wonson, of Gloucester, states that the crew of a "pogie-catcher" consists of about 10 men, and that the cost of a three weeks' trip is about \$400.

Menhaden fishing in Maine.

176. Mr. Church has furnished a very full account of the organization of crews on the seining-vessels. The largest steamers are 70 tons in burden, the smallest 25, the sailing-vessels about 30; these vessels are used for the men to live on, and tenders are employed to carry the fish to the factories. These tenders have an average capacity of 250 barrels, though recently they are built of a larger size, some carrying 600 barrels. Besides these there are the "purse" and "mate" boats from which the seine is worked. These are 28 feet long, 6 feet wide, and 2 deep. The sailing-vessel has a cook who manages the vessel while the crew are working the seine. Each boat carries a "seine-setter" and two men to row. The captain of the gang is in charge of the "purse-boat," the first mate of the other, and in addition to these most gangs have a "fish-driver," who keeps close to the school in a small-boat and guides the gang in setting the seine. Some gangs have still another man, called the "striker," who is generally an apprentice learning the business and working at low wages. Four men to row, two to set the seines, and one (the cook) to manage the vessel, seven in all, are all that are really necessary for steamer or sail-vessel, the other functionaries being added as may be convenient. "The seines are 280 fathoms long and 100 feet deep. One-half of the seine is put in each boat. The steamer cruises with men at mast-head looking for fish. When they raise a school they put what are called striker-boats on them. Each steamer has two, with one man in each; they are men with sharp eyes, quick and active. They row close to the school of fish, observe its course, and then by signs they direct the purse-crew how to set their seine to catch them. If fish get scared, they drive them with white sea-pebbles which they carry in their boats. If the fish turn to run out of the seine, they throw the pebbles before them, and as they pass through the water before them the fish turn and swim in an opposite direction. After the fish are surrounded the purse-crew and strikers all work together to get the seine around them. It is different from sail-gangs in this, that sail-gangs hoist the fish by hand, and have boats to take the fish from the fishing-grounds to market, while the purse-crew stay on the ground with a separate vessel. Steamers go on the ground, catch their fish, hoist them on board by steam, and when the day is done take them to market, and the same men that catch them discharge them." A steamer has no tenders, and thereby saves much

expense. A sail-vessel with a purse-gang of seven men requires three tenders, with a man to sail each of them, making ten men in all as sharesmen. The steamer dispenses with the three extra men, and in consideration of the expense of coal and machinery takes their three shares. This leaves the shares of the remaining men proportionally the same as on a sailing-vessel.

Sail-gangs and steamers have gear just alike to catch the fish. It is not a sure thing to catch even when they see plenty of fish. A gang last year set nineteen times and did not catch a fish.

A writer in the Boston Daily Advertiser newspaper of August 5, 1875, states that persons chartering a steamer and sharing equally the profits with its owner easily make from \$1,000 to \$3,000 in a season.

Boardman and Atkins thus describe the methods in use about Boothbay, Me., in 1874:

“Attached to each seine is a gang of fishermen and boats. The gangs are described as ‘sailing gangs’ or ‘steamer gangs,’ according to the means of locomotion. A sailing gang comprises two working boats and a light row boat for the ‘driver’; two carry-away boats, with a capacity of about 250 barrels each; one vessel and ten men in all. The working boats work the seine, the carry-away boats carry to the factory, and on the vessel the crew are fed and lodged. In a steamer gang, the vessel and the carry-away boats are replaced by a screw-steamer of 35 to 60 tons (new measurement), and the number of men is reduced to nine. These steamers cost from \$10,000 to \$16,000 each, and will carry 800 barrels of fish. They were introduced on the coast of Maine three years ago. The advantage of the steamer over the sailing gang is obvious. It is not dependent on the wind, and can proceed without loss of time to the place where the fish are playing. Of course they catch a great many more fish, but they are so much more expensive that they do not appear to be much more profitable. The seine gangs are always attached to the oil-factories, and the latter employ no other mode of fishing. Each factory runs several gangs.

“Let us now follow the process of catching the fish as practiced by a steamer gang. We will begin at the sailing of the gang from the harbor, some clear morning in August. The engineer bestirs himself and has on steam early enough to reach the fishing-ground about as early as the fish can be seen. The fishing-ground is just where experience, and particularly the experience of the last few days, dictates. Commonly it is out to sea. As soon as it is light a sharp watch is kept on every side. Wherever menhaden are seen, thither the steamer’s head is pointed. Sometimes it is close by home, and sometimes twenty or thirty miles are passed over before there is a single school to be seen. On approaching a playing school they always try to get on the outside of it, because the first movement of a school of pogies on finding themselves entrapped is invariably a rush seaward. The driver, in his swift row-boat, armed with a pile of stones, gets on the other side. Having

divided the seine between them, one end and half the seine being on each, the two working boats approach the school within a short distance and endeavor to get in a favorable position. Sometimes a whole day will be spent in vain endeavors to get near swiftly moving or capricious schools. When the favorable moment comes the boats separate and row around the schools of fish, paying out the seine from each as they go. Meanwhile the driver, on the opposite side, throws stones at the timid fish and starts them in the direction of the boats. At last the boats have encircled the fish, and meet on the side opposite to their starting point; instantly the purse-lines are seized, and no man stops to breathe until the bottom is pursed up. The crews exert themselves to complete the operation before the fish take the alarm, and many a time it happens that they pass out between the boats just before they meet, or under the bottom of the seine before the pursing is complete. The affrighted fish first, it is said, rush seaward. Finding themselves shut in on that side, they turn and rush landward; headed off there, they furiously follow the net around at the top of the water, some going this way and some that. Finding the circuit complete, they gradually subside, and finally settle to the bottom of the bag. The seine is now drawn aboard the working boats until only a small portion of it is left in the water, and the fish brought in a compact body to the surface. The steamer is now brought alongside, and with a great tub holding two or three barrels, and worked by steam, the fish are rapidly taken on board. When everything works well it takes about two hours to catch and take on board a school of 500 barrels; commonly it is longer than that.*

Gill-net fishing in Eastern Maine.

177. East of the Penobscot River, in Maine, most of the fishing is carried on with "float" or gill nets. These are knit usually of twine (size No. 12 to 14, 4-threaded), and of $3\frac{1}{2}$ to 4 inch mesh, and are from 30 to 180 feet in length and from 6 to 16 and 24 feet in depth; usually from 12 to 18. Two men in an open sail-boat will, according to Mr. W. H. Sargent, of Castine, take care of a dozen nets. These nets are usually set in the night by being anchored in favorite haunts of the menhaden. When a school strikes the net large numbers of the fish are "meshed" by running their heads through the openings until they are caught by the gill-covers. According to Mr. Brightman, of Waldoborough, the gill-netting in that vicinity is mostly done early in the season; he states that this method of fishing is not nearly so productive as in former years. Netters sometimes build a furnace for trying out oil on the deck of a small vessel, thus saving the trouble of transportation.

Gill-nets are also used about Boothbay in the early part of the season, but not so much as formerly. The nets are made, according to Mr. Brightman, of fine cotton twine, about 4 inches mesh, 12 feet deep, and 20 fathoms long.

* Op. cit., pp. 24, 25.

Until the introduction of the purse-seine and its general adoption, about the year 1860, gill-nets were exclusively used. In the intermediate time the stationary gill-nets were supplanted by sweep-nets, arranged by fastening together several small gill-nets.

Weir fishing for menhaden.

178. Weirs and pounds are never set for the express purpose of capturing the menhaden, but large numbers of these fish are taken in these traps. In Chatham Bay, Massachusetts, there are thirteen weirs of various lengths set in water from 2 to 5 fathoms in depth for the purpose of catching mackerel, sea-bass, and shad. The average catch of menhaden for the past five years has been about 5,000 barrels, about half of which is sold for bait, the remainder thrown away. Goodale and Atkins state that on the coast of Maine there are a very few weirs built especially for the capture of menhaden; two or three near Stockton, on Penobscot Bay, being all of which they have knowledge. Some are also taken in the weirs built for salmon and alewives. The herring-weirs, on the other hand, are not adapted to their capture, their entrances being so wide that the menhaden generally "play out" after once entering.

On the eastern end of Martha's Vineyard are numerous pounds, extending 1,200 feet and more from the shore, set for sea-bass, squeteague, scuppaug, and bonitos. Many menhaden are taken here, which are sold for bait.

In the vicinity of Greenport, N. Y., "'longshore seines" are sometimes used, though not so generally as in former years, when this was the usual mode of capture.

Colonel Lyman on weir fishing at Waquoit.

179. Col. Theodore Lyman has given a very graphic account of the capture of bait menhaden in the Vineyard Sound:

"The weir is hauled once a day, and always at slack water, because with a strong tide running east or west it is impossible to handle the bottom-lines. The men pull out in two parties, of which one in a large scow passes round the outside of the bowl, casting off the bottom-lines, while the other in a yawl-boat pushes inside the bowl, pulls up the sliding poles, and closes the entrances. The slackening of the bottom-lines allows the bowl-net to hang free, and the crew inside begin to haul up the bottom of this net in such a way as to work the fish toward one corner, letting the net as it comes to the surface pass under their boat, which is thus slowly drawn across the bowl toward the corner where the capture is to take place, and where the scow is already waiting outside.

"The scene now becomes an exciting one. The menhaden in thousands begin to show the sharp upper lobes of their tails above the water;

here and there darts a feverish mackerel like a blue and silver flash; great leathery skates, looking like pigs rolled out flat, raise their snouts in slow astonishment; here a shark suddenly works his way through the crowding mob; hundreds of goggle-eyed squid, smothered in the press, feebly ply their force-pumps; and there the murderous bluefish, undismayed by imminent death, glares fiercely and snaps his savage jaw to the last. All these, with flat-fish, sea-robins, butter-fish, and many more, are taken and rolled in a fluttering mass iridescent with changing colors, and shower their silver scales high in air. It moves even the wear-men, in their oil-skin clothes, with a slight excitement as they cull out from the menhaden the choice and the offal fishes. There is Uncle Abishai smiting sharks with a spear, like so many Sauls, and he smiteth them not twice, and Captain Ed'ard endeavoring with a swift scoop-net to capture a dodging shad, because Mrs. Asa has boarders and needs a fish for dinner; and Captain Charles, with the air of one who gets a toy for a good child, diligently striving after some of them 'ere striped robins that the professor wanted. All this is strange and entertaining even to a commissioner, who, by the motion of a long swell and the evil piscatory odor, is somewhat afflicted with what the local satire terms 'white-ears.' And now the menhaden, bushels on bushels, are scooped all quivering into the great scow, for a little outside lies a mackereler who has just let go her anchor with a rattle, and a boat is pulling in with the skipper to buy bait. 'What you got,' cries he, in an indifferent tone. 'Menhaden,' retorts Captain Warren, as if speaking of a new and scarce fish. (A pause.) 'I don't know but I might take a few barrels if they was low,' says the skipper. (No reply.) 'What do you want for 'em?' 'Eighty-five cents,' shouts Captain Warren, and then (*sotto voce*), 'I don't believe he's got a scale.' At this answer, the man of mackerel pushes over the tiller and steers off indignantly; but presently pauses, 'Give you sixty five, for seventy barrels.' 'Seventy-five cents is the lowest,' replies Captain Warren. 'Call it seventy cents for seventy-five barrels.' 'Waal! Waal!' And by this time the scow is full, and the weir-men pull for the vessel, whose numerous crew is ready to hoist the bait on board and salt it down. They stand with knives, barrels, and chopping-blocks, and rapidly cut off the heads and tails of the fish, and the thin parts of the sides, then give a gash in the shoulder, and throw them into the barrel for salting. A mackereler will take as many as 120 barrels of such bait, which is minced fine in a hand-mill and thrown over to toll the fish.

"Many years ago, when mackerel were cheap, the younger ones, called 'No. 3s,' were laboriously chopped up with a hatchet and thrown over as 'chum.' When mackerel became dear, especially during the war, the No. 3s were too valuable to be thrown away, and cheaper material, such as menhaden, was resorted to."*

*Ann. Rep. Commissioners on Inland Fisheries, for the year ending January 1, 1872, pp. 24, 25.

Fatback fishing in North Carolina.

180. At Cape Hatteras, according to Mr. A. W. Simpson, two kinds of nets are used in the capture of the "fatback." The "drag-net" is from 75 to 100 yards long, and 25 to 37 meshes deep, with a mesh of from $1\frac{1}{2}$ to 2 inches. The lead line is provided with heavy lead sinkers, the cork line with floats made of gum-tree roots. The "set net" (which like the preceding is made of gill-twine No. 25 or 30, and five or six strand cotton cord made of No. 10 cotton) is from 35 to 45 yards in length, 18 to 20 meshes deep, the mesh being the same as in the "drag-net." Instead of a lead line is used a heavy cotton cord which has been dipped in pine tar and rolled in a bed of pebbly sand until a sufficient quantity is fastened to it to weight the bottom of the net. Such a net is called a "fly-tale," and is set at night on the playing ground of the fish, with both ends made fast. To work these nets canoes are used, ranging from 16 to 30 feet in length and $3\frac{1}{2}$ to 7 in beam; two men are required for a small canoe, three for a large one. The fish are taken mostly on the flood-tide. When fishing with the drag-net, moderate weather is preferred; with the gill-net, a light wind, as the fish run most in windy weather. The fishermen do not make a special business of catching the menhaden, but are on the lookout for all kinds of fish. Purse-nets have been used about Cape Hatteras, but without very great results.

In the rivers near Beaufort, N. C., according to Mr. Davis, the fatbacks are taken in gill-nets about 50 fathoms in length, and 50 or 60 meshes deep, the meshes being $1\frac{1}{4}$ to $1\frac{1}{8}$ inch in dimension. Nets which are partially worn out are generally used, the fishermen having an idea that the slime of the fatback ruins a net so that it cannot be used after the first season. The nets are worked from open boats and canoes carrying from 10 to 25 barrels of fish. Two men and a boat are necessary for each net. In making what is called a "drop," from four to six boats join their nets and surround the school. The fish, getting confused, mesh themselves and are easily pulled in with the net, and are then disentangled. From two to four hours are necessary for each haul, and one haul will generally fill the canoes. Two loads can be taken in a day.

33.—THE RELATION OF THE MENHADEN FISHERY TO THE FISHERMEN
AND THE MARITIME VILLAGES.

181. On the coast of Maine, according to Mr. Maddocks, "the catching of menhaden is a favorite occupation with fishermen. The steamers return every night if they have any fare, and are hardly ever absent more than two or three days. Operations are suspended in bad weather. The oil is manufactured at once, and meets a ready market. The men can thus be promptly paid; whereas in the mackerel and cod fisheries the hands are obliged to wait until the end of the season for settlement, the service is dangerous, and comparatively full of hardships, the Men-

haden Association has never lost a man in its service, and not one of the steamers has ever burst a boiler. This is the more important since the cod and mackerel fisheries have been and are grievously oppressed, and greatly reduced by the tariff regulation that admits English fish free to our markets. The Englishman can build his craft at less cost than the American, can fit and equip her cheaper, and can therefore afford to sell his fish at a lower figure than the home fisherman; and at the same time he pays none of our taxes while enjoying the benefit of our market. The menhaden fishery has afforded no little relief in this condition of things to the unemployed fishing population on our coast and elsewhere."

182. Mr. Maddocks gives a very interesting picture of the influence of the menhaden fishery upon the population of the neighboring shores.

In the villages of Boothbay, Bristol, Bremen, and East Boothbay, the centers of the menhaden fishery on the Maine coast, the number of dwellings has doubled in the past few years, and all the outward signs of thrift, of enlarged comfort and abundance manifest themselves. The companies engaged in the menhaden business pay in the aggregate a handsome per cent. of the annual taxes of the towns in which they are located. The oil companies of Bremen pay over one-fourth of the total tax of the municipality. The oil-factories of Boothbay have, since they were built, paid an amount of tax equal to two-thirds of the war debt of the town. The Bristol factories pay one-eighth of the town tax. The indirect contributions of the business to the public treasury, by promoting the building of houses, vessels, &c., have been very considerable. All the money made has been spent on the spot, where it is open to taxation.

"About \$60,000 worth of cotton twine is used yearly in the menhaden fishery of Maine for the manufacture and repair of seines. Quite a number of hands, men, boys, and girls, are employed in this work. The seines are of course made by machinery. Ten thousand tons of coal are consumed for various purposes, and 40,000 bushels of salt."

A correspondent of the "*American Agriculturist*" states in that paper* that the proceeds of the menhaden fishery and industry between New London and Stonington in 1872 amounted to \$113,000, which was distributed along the coast of 12 miles on the north side of Fisher's Island sound. The business gave employment to over 200 men at the factories, and indirectly to as many more, besides the business of freighting the products.

34.—PROTECTIVE LEGISLATION.

Laws of Maine.

183. The legislative acts relating to the menhaden fishery in Maine are summed up as follows:

SEC. I, chap. 313, Public Laws, 1865, provides as follows:

"No person shall set or use any seine within three miles of the shore

* *American Agriculturist*, 1873, vol. XXXII, p. 139.

in any waters of this State, for the purpose of taking menhaden or pogies; but a net of no more than one hundred and thirty meshes deep shall not be deemed a seine." * * * *

The penalty for violation of this act was fixed at "not less than four hundred nor more than one thousand dollars, and the forfeiture of all the vessels and apparatus employed."

By the act of February 21, 1866, chap. 30, Public Laws, the penalty for violation of the law was reduced to "not less than one hundred nor more than five hundred dollars," and the number of meshes deep increased to one hundred and forty to constitute a seine.

The act of February 27, 1869, chap. 36, Public Laws, repeals the foregoing, and re-enacts it in substance with various modifications.

The legislature of 1870 re-enacted the above with fuller details as to the collection of penalties, &c. Chap. 120, Public Laws, 1870.

In the revision of the statutes in 1871 the above act was consolidated into one section, sec. 54, chap. 40, Revised Statutes, 1871, which still retained the three-mile restriction, and the penalty of one hundred to five hundred dollars for each violation, and a forfeiture of all equipment employed.

Chap. 211, Public Laws, 1871, approved February 27, 1871, repeals the above sec. 54, chap. 40, of the Revised Statutes.

Laws of Massachusetts.

184. The following acts have been passed by the legislature of Massachusetts:

"AN ACT to protect the menhaden fishery in the towns of Duxbury, Plymouth, and Kingston.

"(Ch. 85.) SECTION 1. *Be it enacted*, Every person who shall, between the first day of May and the first day of November, inclusive, in each year, deposit the offal or waste dressing of the menhaden fish upon the shores or flats, or throw the same into the waters of the bays, harbors, rivers, or creeks of the towns of Duxbury, Plymouth, or Kingston, shall, for each and every offense, forfeit and pay a sum not exceeding fifty dollars, one-half to the complainant, and the remainder to the town within whose jurisdiction the offense was committed, to be sued for and recovered in any court competent to try the same, on complaint of any one of the selectmen, or any legal voter of either of the towns of Duxbury, Kingston, or Plymouth.

"SEC. 2. Any boat, craft, vessel, or fishing apparatus used by persons violating the provisions of this act, may be seized and detained not exceeding forty-eight hours by the selectmen of either of the towns aforesaid, in order that the same, if need be, may be attached or arrested by due process of law, to satisfy said fine with costs.

"SEC. 3. This act shall take effect from and after its passage."—[April 24, 1857.

"AN ACT regulating the seining of menhaden in the rivers of the commonwealth.

"(Ch. 52.) SECTION 1. *Be it enacted*, The mayor and aldermen of any city or the selectmen of any town situated upon or adjacent to any river in which the seining of the fish is now or may hereafter by law be prohibited, may, upon the petition of twelve or more legal voters, and after due notice and hearing thereon, grant permission to such persons, upon such condition and with such restrictions as they may see fit, to seine menhaden therein, if, in their judgment, the same is consistent with the public good: *Provided, however*, That in all cases where two or more cities or towns are situated upon such waters and interested in said fishery, no action shall be had except upon petition to each of them, and by their concurrent vote.

"SEC. 2. If any person so licensed shall exceed in any manner the terms of said permission, or violate any of the conditions thereof, he shall be subject to the same penalties as would attach to seining without such license.

"SEC. 3. Such license may be altered or revoked at any time, by the concurrent action of the municipal authorities granting the same."—[March 15, 1858.

"AN ACT relating to the taking of menhaden in the waters of Buzzard's Bay and Vineyard Sound.

[1856, ch. 176. Additional act, 1870, ch. 249.]

"(Ch. 212.) SECTION 1. *Be it enacted*, From and after the passage of this act it shall be lawful for any person to take menhaden by the use of the purse-seine, so called, in the waters of Buzzard's Bay or of Vineyard Sound, or the waters of any bays, inlets, or rivers bordering on or flowing into the same: *Provided*, That no authority shall be hereby given to use any such seine at the mouth of any river where there now is or where there may hereafter be a herring fishery established by law, until after the fifteenth day of June, in each year: *And provided further*, That no authority shall be hereby given to use any seine in the waters around Nantucket or the islands belonging thereto."—[May 9, 1865.

In the report of the commissioners of inland fisheries for 1877, p. 65, it is stated:

"Fishing with seines in the Merrimac, at the season when the menhaden stand in, is forbidden by law. The *mouth* of the river has, however, never been defined by the governor, as permitted by statute; and it was represented to the commissioners that valuable menhaden fisheries existed in this neutral ground of brackish water. Therefore, under the personal promise of the fishermen to capture no shad or salmon, and with the guarantee of responsible persons in Newburyport, the commissioners agreed to defer the definition of the river-mouth, and to assume that these menhaden were not positively included in the river proper."

K.—ECONOMICAL VALUE AND APPLICATION.

35.—THE MENHADEN AS A TABLE-FISH.

Its use in a fresh state.

185. In many parts of the United States menhaden are in favor as table-fishes. When perfectly fresh they are superior in flavor to most of the common shore-fishes, but if kept they soon acquire a rancid and oily flavor. The Maine fisherman finds his breakfast of fried pogies both substantial and palatable. I can testify from personal experience that a bony-fish chowder is not to be despised.

They are often eaten in the vicinity of Newburyport, under the name of "hard-head shad." They are considered more palatable than the early runs of the river shad.

I am indebted to Mr. Barnet Phillips, of the New York "Times," for the information that in 1813, during a season of scarcity, large numbers of moss-bunkers, both fresh and smoked, were consumed in New York City. It does not appear probable that they were ever extensively used for food except in seasons of scarcity.

Professor Gill, writing in 1856 of the fishes of New York, remarks that moss-bunkers appear in the markets in the fall months, but in small quantities.

Storer remarks* that the fishermen who supply Boston market with codfish set their nets about the outer islands in the harbor each night as they come up to the city, and examine them in the morning as they go out for the day's fishing. Large numbers of menhaden are thus taken, frequently one hundred barrels at a haul, and such as are not used for bait are sold to the poorer classes for food, at about $6\frac{1}{4}$ cents per dozen.

The Rev. A. W. Church, editor of the Middletown (Conn.) "Constitution," informs me that the moss-bunker is a staple article of food among the people living on the sea-coast of New Jersey in the vicinity of Bricksburg, Somers Point, etc., and ten or fifteen miles inland. Every family makes a practice of salting down a barrel or two for winter use. They are preferred to any other fish which can be taken in that vicinity.

In the fall and winter the alewife is in good demand on the shores of Chesapeake Bay. In November and early part of December, 1874, I frequently saw twenty or thirty strings on the tables in the Washington fish market and they seemed to meet with a ready sale at 40 cents a string, a price nearly as high as that of striped bass, the favorite fish in Washington.

At Cape Hatteras the winter fish are in demand and are salted in quantity for summer use. In 1873 they sold for \$7 a barrel. The summer fish are used only as fertilizers.

* Hist. Fish. Mass., p. 159.

The abundance of bones and the oily flavor have given rise to a prejudice against the menhaden as a food-fish, which the oil factories on the coast have done much to confirm. Still the fish is not unpalatable, and is capable of much valuable service in the capacity of a table-fish.

Its use salted.

186. For many years salted menhaden have been shipped from Gloucester to the West Indies and Guiana, to serve as food for the negroes upon the plantations. These fish are not carefully prepared, but are chiefly the surplusage of the bait supply remaining in the hands of outfitters of fishing vessels at the close of the season. They sell for about \$2 per barrel. Mr. F. W. Homans ships from 1,500 to 2,000 barrels annually to Surinam. These would weigh from 300,000 to 400,000 pounds, and be worth in the aggregate some three or four thousand dollars. Other individuals doubtless dispose of their refuse stock in the same manner.

Capt. Moses Pettingell, of Newburyport, informs me that about the year 1840, and before, large quantities were annually salted down in Newburyport, to supply a regular market in the West Indies. Salted menhaden were found to meet with a readier sale than salted mackerel, since, while little inferior in quality, when well prepared, they could be sold at a much lower price.

In the "Topography and History of Wareham," 1815, it is stated that the inhabitants of Wareham and Plymouth were accustomed to vote to allow a certain number of barrels of alewives to be taken annually from the brooks within town limits, and that "menhaden were also taken in quantity at Wareham and barreled for exportation in former years."*

It is stated by the editor of Forest and Stream† that some Brooklyn people have a patented process for extracting the bones and superfluous oil from the menhaden or moss-bunkers, hitherto useless as food, and then salting the fish, which they claim are fully equal to No. 3 mackerel. Thus all parts are utilized.

Salt mackerel at times replaced by menhaden.

187. The inspection returns of Massachusetts show a curious relation between the annual returns of salted menhaden, alewives, shad, and mackerel. An examination of the table given in Appendix G shows that an effort was made during the season of scarcity in the mackerel fisheries to supply the demand by the use of menhaden.

The question of drawback on salt.

188. Capt. Fitz J. Babson, collector of customs for the port of Gloucester, states that the question yearly comes up as to whether the menhaden fishermen are entitled to privileges under the law granting

* Collections | of the | Massachusetts | Historical Society | — | vol. iv. | of the second series. | Boston : | printed MDCCCXVI | : p. 284.

† Vol. II, 1874, p. 215.

drawback on salt used in pickling, nets, and fish. This discussion brings on the question whether menhaden are or are not "food-fishes." The decision has usually been made that they are food-fishes.

36.—FOOD PREPARATIONS DERIVED FROM MENHADEN.

The manufacture of sardines.

189. On the coast of New Jersey, near Port Monmouth, are several factories, which carry on an extensive business in canning menhaden in oil and spices. One of the largest of these is that of the American Sardine Company, a representation of which is given in Plate XXIV. Mr. F. F. Beals, of New York, gives the following description of the methods in use in this establishment:

"We aim to have our catch of moss-bunkers in by 6 or 7 o'clock a. m., as the fish seem to be strongly impregnated with phosphorus and soon spoil in warm weather. As soon as the fish are landed, we put our entire force of men to cleaning, cutting, and scaling, for which we have machines adapted. When the fish are cleaned, they are at once put in hog-heads, and salted just sufficiently to keep and to remove their extreme freshness. They are then packed in cooking cans, which are a little larger than the packing cans, and put into the tanks, where they are steamed for the space of about two hours. After the fish are taken out, they are placed in the regular market cans, which are then laid upon zinc-covered tables, where they are filled with salad oil. They then go to the tinner, who solder on the lids, after which the can is again steamed and vented, and passed up into the cleaning and labeling room. Each day's work is piled up separately, each can being thoroughly tested to see that it is perfectly air-tight. For this we have an experienced hand. Not a can is packed until it has stood for at least a month. At the expiration of this time, after being again tested, the cans are packed in wooden cases containing two dozen each, and are then ready for the market. As we make all our tin cases, we are able to secure good results, and it is a rare occurrence to have a swollen can. If there is one, it is at once thrown aside.

"Our company was incorporated April 21, 1871, under the laws of the State of New York. Seeing the magnitude of the sardine business on the other side of the Atlantic, we were impressed with the idea that there was a large field for operations in this country alone. We at once set about to find a fish which would supply the place of the European sardine. After many experiments, we at last found one to suit the purpose, viz, the moss-bunker, and commenced a series of experiments to find a means of extracting or softening the bones without the use of acids of any kind. After over a year of experiment, we at last found the desired process, which we secured under United States letters patent, dated May 21, 1872. This process consists of various modes of steaming until the bones become so soft that they can be eaten, like the flesh of the fish, without the slightest inconvenience. The two first years most of our time was con-

sumed in experimenting, so that it was not until a year ago that we really commenced to manufacture, though prior to that we put up some goods. Last year, 1873, we packed and sold about 30,000 dozen whole cans or boxes. We have now capacity to turn out double that amount and we expect to be obliged to do so, as our trade is rapidly increasing. Our goods have received various awards, including a medal of merit at Vienna in 1873, and a silver medal at Bremen in 1874."

During the season of 1877, the works of the American Sardine Company were not in operation. Mr. Beals, the secretary, informs me that the manufacture will be pressed strongly in 1878.

The qualities of American-sardines.

190. Many persons are incredulous with regard to the possibility of manufacturing sardines of good quality from the menhaden. It need only be said that they have been carefully tested by many unprejudiced judges in the city of Washington, and that the verdict has always been that they were almost equal to French sardines of the best brands. There can be no reasonable doubt that if olive oil of good quality were to be substituted for the cotton-seed oil now used in the preparation of American sardines, they would be fully equal to similar articles imported from abroad.

The American sardines should be carefully distinguished from the sardines prepared at Eastport, Me., from young herrings; they are sealed up in tin cases imported ready-made from France, and are put upon the market in the guise of foreign goods—a misrepresentation which is not at all necessary, since they are quite as good as the articles with which they profess to be identical.

Menhaden preserved in spices.

191. There are other establishments near Port Monmouth which prepare menhaden in spices and vinegar under the trade names of "Shad-ine," "Ocean Trout," and "American Club-fish." I have been unable to obtain statistics of this branch of manufacture. Hoope & Coit, of New York, contributed samples of these preparations to the Centennial collection of the United States Fish Commission, and I suppose this firm to be engaged in the manufacture.

"Russian sardines" are prepared at Eastport, Me., from the herring, and are branded with spurious names and labels imported from Germany.

Mr. Barnet Phillips describes, in the New York Times, a visit to the "ocean-trout" manufactory at Port Monmouth. He writes: "If the name of the *salmonidæ* be taken a little in vain, the trout manufactured out of moss-bunkers are by no means to be despised. "Ocean trout" may not be the *garum* cooked with Tragascæan salt, but is a fair fish-food and as an alimentary substance is in good demand. The process of manufacture is simple. The fresh fish are scaled by machinery, by means of a revolving wheel, are then cooked in steam, packed into

boxes, which boxes have a cover put on them perforated with a couple of holes. The box containing only the fish is then plunged into a bath of pickle, where it remains until it fills itself, then the box, now full of fish and pickle, goes through a second cooking. When all hot, filled with steam, the two minute holes are closed with solder, a label is put on, and the moss-bunker, now metamorphosed into "ocean trout," instead of being turned into oil or being employed as a top-dressing for sterile soil, makes quite a delectable food, and doubtless to-day the advance of civilization in the United States is shown in remote portions of the country by cairns made up entirely of empty tin boxes once filled with edible moss-bunker.

Goodale's "Extract of fish."

192. The Hon. S. L. Goodale, of Saco, Me. (secretary of the Maine Board of Agriculture from 1856-1873), has inven'ted a process by which the juices of the flesh of fish are extracted to form an article of food which promises to be of much commercial value. He writes: "Some time since the idea was conceived by me and reduced to practice of concentrating the juices of the flesh of fish into a food extract. The attempts were successful and the product satisfactory, bearing close resemblance to Liebig's *extractum carnis*, and possessing a like percentage of saline constituents and extractive matter, soluble in alcohol. My results thus far indicate that the more abundantly occurring *Clupeidae* appear to be much better adapted to this use than any other fish yet tested, especially the menhaden and the herring, the latter having a more distinctively fish flavor, the former more nearly a simply rich-cooked meat flavor. The alewife I have not yet proved, but anticipate excellent results from its employment.

"During the two seasons past I have worked a few barrels of menhaden at a time, at intervals of a fortnight or more, to see if the juices varied in flavor or richness. My apparatus is imperfect, and although the extract *must be*, judging from my former experience with beef extract, inferior in flavor to what it would be if prepared with a vacuum pan and all suitable conveniences, it is good enough to elicit many commendations. No one needs less than yourself to be told how great are the possibilities for this new project. From each barrel of menhaden, as taken, I get three pounds of extract when flesh alone is used and four pounds if the spine is retained in dressing. And my rejections yield just as much oil and scrap as any manufacturers get who treat them for this alone. The skins may be used to make glue. I remove them by scalding quickly, in either mode of dressing. The details of manufacture are fully worked out.

Considering the large amount of fish annually taken and hitherto treated for oil and scrap alone, the juices of which have been allowed to run back into the ocean as a worthless by-product, I cannot avoid the

conclusion that a new source of food is within reach, which at no distant day may contribute materially to human welfare."

Mr. Goodale exhibited specimens of the extract of fish at the International Exhibition in Philadelphia.

The writer has had an opportunity of testing the qualities of the preparation and can testify to its agreeable flavor and manifestly nutritive properties. Two tablespoonfuls of the jelly dissolved in hot water yield a large dish of savory soup, most closely resembling the *potage consommé* of the French cooks.

Professor S. W. Johnson, of Yale College, wrote to Mr. Goodale: "I cannot doubt that the fish extract is entirely new, and as food or stimulant is equal to beef extract in all respects (except *possibly* in the matter of iron*), and if put into the market in the proper shape would shortly share the patronage now so largely bestowed on beef extract, &c." And again: "I find your extract of fish both by actual use and by chemical analysis in all respects equal to the best Liebig's extract of beef.

Mr. Frederick Law Olmstead, of New York, wrote: "I have made a trial of your extract and find it more palatable than any beef extract I have used. It is not at all fishy, but I think it has a slight distinctive agreeable flavor which is also found in rich fish gravy. I am strongly disposed to regard it as a very important invention."

The extract of fish has also been tested in hospitals in Portland, Me., and in New York City. Concerning the latter, Professor Johnson may again be quoted: "The fish extract was tried in this hospital. The physicians consider it in no way inferior to Liebig's. It was not suspected by nurses or patients to be anything else."

Possible yield of "extract of fish."

193. Mr. Goodale estimates that the fish used by the factories in the towns of Bristol and Boothbay, Me., in 1873, 1874, and 1875, allowing the product to equal one-fifth of the weight of the live fish, would have yielded in either year upwards of a million of pounds, or five hundred tons of extract of fish. Carrying out the same calculation for the entire catch of the Atlantic States the potential yield of the menhaden fisheries would exceed ten millions of pounds.

37.—MENHADEN AS FOOD FOR ANIMALS.

Menhaden scrap as food for cattle and poultry.

194. At a meeting of the "Maine Board of Agriculture and Farmer's Convention" at Wiscasset, Mr. Wasson gave an interesting account

* With regard to Professor Johnson's suggestion of possible difference in contents of iron, I cannot speak confidently, but my impression is that this element occurs mainly if not wholly in the blood corpuscles; that these are entangled in the albuminous constituent, as it coagulates in boiling and are removed in the serum which rises and is taken off, consequently that iron would not be found in appreciable quantity in extract made from either beef or fish.—S. L. GOODALE.

Professor Johnson's later analyses seem to confirm the impression of Mr. Goodale.

of the use of "porgy chum" as a food for sheep and poultry, stating that he had used it for five years. To prepare it for food it is prepared by drying it in the sun for two days on elevated racks, thus expelling a large portion of the water. When thus dried it will keep for an indefinitely long period. Mr. Wasson had kept a quantity in an open barrel in his barn for at least five years. One barrel, costing \$2, was sufficient to feed three sheep during the entire winter. Sheep thus fed showed an average increase each of one pound and a quarter of wool, while they were constantly fat and brought heavy lambs. Hens also ate the scrap with avidity. Mr. Thomas Boyd of Boothbay, stated that hens, ducks, and turkeys prefer it to corn, and become large and heavy when fed upon it. It is customary to discontinue the scrap and feed them on corn three or four weeks previous to killing them. Professor Charles A. White inquired in regard to its effects upon the quality and flavor of the meat of animals fed with chum, stating that hogs fed in the acorn or mast region of the west do not make such firm sweet pork as those fed on corn. None of the members present were able to answer this question.

Mr. Luther Maddocks, of Boothbay, a leading manufacturer, stated that if a demand should occur for scrap to be used as animal food, it could be so pressed as to retain only 25 per cent. of water, and in that form it would be more suitable for transportation. Ordinarily it contains about 50 per cent. of water.

Apparently this subject deserves careful investigation. In the Norwegian Department in Agricultural Hall at the International Exhibition of 1876 were exhibited some biscuits made from "fish-flour," a preparation invented by the late Anton Rosing, a prominent agricultural chemist of Norway. These biscuits were in good condition after having been kept for ten years in an unsealed jar. They were intended to be applicable to the uses of soldiers, miners, and farmers, to whom a supply of fish, other than salted, is beyond reach. The editor of the *American Agriculturist* suggests that a similar process might be employed in utilizing the refuse of the oil manufactories as food for stock.* The proper preparation of this material for feed, either alone or mingled with bran, corn-meal, or other products of grain, would doubtless be a great economy, both for feeding and enriching the manure.†

L.—THE MENHADEN AS A BAIT FISH.

38.—THE USE OF MENHADEN FOR BAIT.

Menhaden as cod bait.

195. Menhaden bait is extensively used in the cod and mackerel fisheries in New England and the British Provinces. Its popularity is no doubt chiefly due to the ease with which it may be obtained in large

* *American Agriculturist*, Vol. XXXV, 1876, p. 314.

† The value of menhaden as a food for animals is discussed more in detail by Professor Atwater in the succeeding part of this report.

quantity, though its oily nature and strong odor render it particularly well adapted for use as a toll bait for mackerel. "Slivered pogies" are carried by the "bankers" or vessels fishing for cod on the Newfoundland and George's Banks from the ports of Gloucester and Provincetown.* According to Captain Atwood, salted menhaden are good bait for haddock but inferior for cod. On the Labrador coast the bait principally used is a small fish of the salmon family known as the capelin (*Mallotus villosus*) large quantities of which are easily procured in those waters for a short period in the summer. The herring (*Clupea elongata*) is the most common bait in the Bay of Fundy cod-fisheries and it is also used by the English "bankers" to a considerable extent, as well as young mackerel. The English vessels also consume a large amount of "slivered pogies" which they buy from Massachusetts vessels. Fresh "slivers" are preferred to those which have been salted, and vessels bound to George's Banks usually carry their bait preserved on ice.

Menhaden as mackerel bait.

196. As a toll bait for the mackerel fishery, the menhaden is better than any other fish. The mackerel seem to prefer it, and the presence of a great quantity of oil renders it especially convenient for the use of fishermen, since a small quantity of ground menhaden bait will spread over a large area of water.

The introduction of the use of menhaden bait.

197. In early days it was the custom to grind up small mackerel for bait, much to the detriment of the fisheries in succeeding years. Captain Atwood remarked in his testimony before the Fishery Commission at Halifax: "We now use menhaden for bait; but when I first went fishing we did not do so. Our practice then was to grind up small mackerel for the purpose. Any quantity of these mackerel were at that time to be found along the coast and plenty of them are there to be met with now. These fish were of no account then, and so we ground them up for bait; and when we could not obtain them, we ground up for bait what you call gurry, the inwards of fish with the gills attached. American fishermen, when they fish with hooks, use menhaden bait almost exclusively. The superiority of this bait over all others is such that when this fish can get menhaden they won't take any other. At first mackerel fishermen were afraid of this bait. It is a very bony fish, and they then thought that if it was cut up for bait, the mackerel would soon get sick of it, owing to the number of bones. There is a species of fish belonging to this family found on our coast which is exceedingly fat. We call them blue-backed herrings; † and some preferred this fish for bait, as it was not so bony as the menhaden; but when the poorer

* Vessels also carry for bait "sea-clams" (*Macra solidissima*) salted, and the common long clam (*Mya arenaria*). The former are preferred by vessels fishing off Block Island and Nantucket to supply the New York market with fresh cod and haddock. They are sold at Nantucket at the rate of 30 cents a bushel.

† The alewife, *Pomolobus pseudoharengus*.

mackerel got to be worth having, about everybody adopted menhaden for bait. It is the cheapest bait.”*

The comparative value of herring and menhaden for toll bait

198. Mr. Sylvanus Smith stated before the Halifax Commission: “All the bait used in mackerel fishing consists of menhaden or porgy, which is only found off the coast of the United States, and which the Canadians bought from the American fishermen to a great extent”†

Also to the same effect Mr. James G. Tarr: “The only bait used for mackerel is the porgy or menhaden, which is found entirely in the United States, and which all the Canadians have to buy from the Americans in a salted state. This fish (the porgy) is not found in Canadian waters, and is almost the only bait used in the mackerel fishery; if the Canadians were unable to procure this bait, they would be compelled to use herring bait, which is much inferior for the purpose. * * * I have known vessels to sail from this port (Gloucester) with as many as 300 barrels of porgy bait on board, which was sold in Halifax and the Straits of Canso to Canadian fishermen. * * * The bait which we buy from them for the cod-fishery consists of herring and some small mackerel.”‡

John E. Saunders remarked: “Fresh herring is used by Canadians somewhat, but it is an inferior sort of bait, and they much prefer menhaden when they can get it. * * * Canadians import menhaden bait from the United States to some extent; the menhaden is not found north of Cape Sable.”§

Richard Hannan, of Gloucester, also stated: “I have sold menhaden bait to the Canadians, a few barrels each year; they import a great deal of this bait from the United States; now by the treaty they can come here and catch this bait themselves. To my own knowledge there have been two or three vessels here from Yarmouth and Argyle which came to catch porgies for use in the bay.||

James G. McKeen, of Port Hastings, Nova Scotia, on the Strait of Canso, stated: “The bait chiefly used by American mackerel-fishing vessels is menhaden or porgies. These fish are taken, I believe, entirely on the coast of the United States, and mostly in seines within three miles of the land, so I have been informed. British mackerel fishermen use the same kind of bait principally, and depend on the United States for the supply. Clams are also used as bait for catching mackerel by both American and Colonial mackerel vessels, and they are obtained chiefly in the United States.”¶

George Critchet, of Middle Milford, Guysboro County, Nova Scotia,

* N. E. Atwood. Proceedings of Halifax Commission, Appendix L, p. 42, September 19, 1877.

† Affidavit 34. Proceedings of the Halifax Commission, 1877, Appendix M, p. 81.

‡ Affidavit 36, *op. cit.*, p. 83.

§ Affidavit 41, *op. cit.*, p. 86.

|| Affidavit 42, *op. cit.*, p. 86.

¶ Affidavit 176, *op. cit.*, p. 195.

stated: "The only bait used by mackerel fishers in the Gulf of St. Lawrence is clams and porgies, and that comes all from the United States."*

Christopher Carrigan, of Lower Milford, Nova Scotia, also stated that, he has been on two trips in the north bay in provincial mackerel vessels and that they used only clams and porgies for bait.†

A similar statement was made by Martin Ryan, of Middle Milford, who had fished five seasons in provincial vessels,‡ and Philip Ryan of the same place, who stated that porgies and clams are universally used in the bay (Gulf of St. Lawrence), although a few provincial vessels may occasionally use herring.§

Andrew Laurie, of Lower Milford, also stated that herring is only used as bait when the vessels of the provincial fishermen are out of porgies and clams, which are better,|| and this was confirmed by Thomas England,¶ Rufus Carrigan,** and Charles Lowrie,†† of Milford, George Laidlaw‡‡ and R. McDonald, of Low Point, Inverness County, Nova Scotia, who remarked: "The only bait American mackerel vessels use is porgies and clams, and that is the bait nearly always used by provincial vessels, but sometimes the latter use herring, which is not a good bait and would not do at all to use as bait in fishing alongside of vessels throwing out porgies and clams."§§

Daniel McDonald, also of Low Point, stated that "ten or twelve years ago or longer there were about 400 or 500 American mackerel vessels in the bay of Saint Lawrence, and during the same time there were about 100 provincial vessels in the bay. The only bait used for mackerel, or almost the only, consists in porgies and clams, and these all come from the United States, whether used by provincials or Americans; a few English vessels use also a little fat herring, but this is used in quantities hardly worth mentioning."|||

James R. Maclean, a merchant of Souris, Prince Edward Island, called on behalf of the Government of Her Britannic Majesty, sworn and examined, testified:

"Question. With regard to the bait in use for cod-fishing and mackerel, where is it obtained?—Answer. They very often use herring and sometimes porgies.

"Q. Where do they get the herring?—A. They catch them around the coast and at Labrador.

"Q. Are herring caught there?—A. Yes; there is a lot of herring taken.

* * * * * * *

"Q. The different fishermen—the large fishermen and the small fishermen—don't they all catch their own bait?—A. Yes, with nets; and for

* Affidavit 188, *op. cit.*, p. 202.

† Affidavit 189, *op. cit.*, p. 202.

‡ Affidavit 191, *op. cit.*, p. 204.

§ Affidavit 192, *op. cit.*, p. 204.

|| Affidavit 193, *op. cit.*, p. 205.

¶ Affidavit 194, *op. cit.*, p. 205.

** Affidavit 195, *op. cit.*, p. 206.

†† Affidavit 197, *op. cit.*, p. 207.

‡‡ Affidavit 200, *op. cit.*, p. 209.

§§ Affidavit 201, *op. cit.*, p. 210.

||| Affidavit 202, *op. cit.*, p. 210.

mackerel bait they take capling—a very fat little fish—and they make out that it is a better bait for mackerel than pogies.

“Q. But the large proportion of the bait is herring?—A. Yes; but they use pogies, which they often buy for bait.

“Q. To any extent?—A. The vessels which go fishing generally buy them. They prefer herring when they cannot get pogies good.

“Q. Where do they buy pogies?—A. They generally buy them on the island, where they are imported.

“Q. They buy them from the merchants?—A. Yes. It would not pay to send down to American waters to fish for pogies for the number of vessels engaged in mackerel-fishing.

“Q. They prefer to take herring, to do that?—A. Yes.*

“Cross-examined by Mr. Dana:

“Q. And your people are buying bait from the United States?—A. They sometimes do so.

“Q. You said that they very often bought pogies, which were used by your people?—A. Yes.

“Q. You mean menhaden—it is the same thing?—A. Yes.

“Q. Where do the merchants get their pogies?—A. From the States.

“Q. Do you really suppose that the American fishermen, instead of buying menhaden from first hands, would buy them of your merchants, paying their profit, and commissions, and freight, and all that?—A. Yes. I have seen these fishermen buy them when their own bait had turned sour or was bad. If the merchants have a quantity of good bait on hand, they can generally sell it.

“Q. Is that considered an article of trade?—A. No; not to a great extent.

“Q. Then the Americans get caught; their bait sometimes turns sour?—A. Yes. Consequently, of course, if out with other vessels fishing, a vessel having bad bait could not secure her share of the fish.

“Q. Can they not catch something else to be used in place of it; herring, for instance?—A. Not always. The mackerel-catchers could not wait for this. Their business is to catch mackerel.

“Q. But they can obtain it at the Magdalen Islands?—A. It would take too much time to cross at that point.

“Q. Your own fishermen could not get across any sooner?—A. No.

“Q. If you could fit out a great number of large vessels for mackerel-fishing, you would want to import a good deal of this bait, pogies or menhaden, would you not?—A. Yes; we would then, likely, import quite a lot of it. They could, however, use herring if no menhaden or pogies were thrown into the fishing ground. Herring would do nearly as well.

“Q. But the fish want something better.—A. Yes.”†

Mr. George Mackenzie, fisherman, of New London, Prince Edward

* Proceedings of Halifax Commission, 1877. Appendix F, p. 24.

† *Ibid.*, p. 29.

Island, witness called on behalf of the Government of Her Britannic Majesty, cross-examined by Judge Foster, testified :

" Question. There is no mistake but what the American bait is a good deal better than any other ; there is no question about that ?—Answer. No ; it is always very well liked, but we have to pay pretty high for it.

" Q. Do you buy it ?—A. Yes.

" Q. How much of it do you use ?—A. I used 20 barrels last year, and I bought 20 more barrels this year, at \$5 a barrel.

" Q. That makes \$100 spent for manhaden bait ?—A. Yes.

" Q. Do you mix this bait with herring ?—A. Yes ; and sometimes we mix it with clams. At the latter end of the season it is that bait which we want. When the fish are poor almost any bait will do, but when they are in good condition they require good bait.

" Q. When do you use herring bait ?—A. In the spring of the year and July.

" Q. Do you mix manhaden with it ?—A. Sometimes.

" Q. If it was not for its expensiveness, you would not use herrings at all ?—A. No.

" Q. Do you use mills to grind the bait ?—A. Yes.

" Q. And you mix the herrings and menhadens together ?—A. Yes ; and we also chop up clams with it."*

And, again, James McKay, deputy inspector of pickled fish at Port Mulgrave, examined by Mr. Hanson :

" Question. On your different trips mackerel-fishing, what bait do you use ?—Answer. Pogies.

" Q. These are generally put up on the coast of Maine ?—A. Yes.

" Q. Where would you buy them if British vessels take them ?—A. Our merchants used to import them from Portland, Boston, and Gloucester.

" Q. To Port Mulgrave ?—A. Yes.

" Q. And sell them as articles of merchandise ?—A. Yes.

" Q. They bought and sold them ?—A. The same as a barrel of flour."†

The testimony of Canadian officers.

199. H. W. Johnson, of the Department of Marine and Fisheries, wrote, in 1868, a " Special Report on the Distress among the Nova Scotia Fishermen." One of the reasons assigned by him for the failure of the fisheries is that " the pogies, the only real mackerel bait, is not caught east of Portland, and must all be imported for our fleet, the increased cost of which, added to the American duty, the fisherman has to pay on his share of fish, besides charges of transportation, place him in the position that if he catches during the season, to his own share, forty barrels of mackerel in one vessel, he has not made as good a season by about \$100, gold, as if he had been in an American bottom."‡

* Proceedings Halifax Commission, 1877, Appendix F, p. 132.

† *Ibid.*, p. 190.

‡ *Ibid.*, p. 67.

Capt. P. A. Scott, R. N., commanding the marine police of the Dominion, reported, in 1870, to the Commissioner of Marine and Fisheries: "For mackerel-fishing the Americans use pogies and clams, chopped fine, as bait. The pogies are found only on the coast of the United States, and when imported into the Dominion cost about \$6 per barrel."*

Capt. Charles G. F. Knowles, R. N., commanding H. M. S. "Lapwing," cruising on fishing-station No. 4, which includes the west coast of Cape Breton and the east coast of Prince Edward Island, reported to Vice-Admiral Fanshawe, November 7, 1870, in these words: "The bait with which the Americans are supplied is far superior to any which can be procured in this country, to which may be attributed in a great measure the success of the Americans previously to the recent restrictions, although, even now, the local fishermen complain that they have no chance while an American schooner is fishing near them."†

200. Professor Hind, in his treatise on the Effect of the Fishery clauses of the Treaty of Washington on the Fisheries and Fishermen of British North America (part 1, p. 75), remarks that its value as a bait for cod is, in a considerable degree, superseded by the herring; but as a bait for "tolling mackerel" it is still in repute, although other fish, similarly treated and finely ground, appear to be equally useful in this respect. The first part of this statement is undoubtedly true, at least as far as the fishermen of the British Colonies are concerned. In regard to the comparative value of herring and menhaden for toll-bait, there is still room for difference of opinion.

An average of, perhaps, 250,000 barrels of mackerel is annually caught by the United States vessels, using menhaden bait solely, against 110,000 caught by the provincial fleet, which appears to use menhaden bait when it can be obtained, buying it at the rate of \$6 a barrel in preference to herring bait, which costs only the labor of catching and the salt for preserving.

Slivering menhaden.

201. The method of preparing menhaden for salting, to be used as bait, is very simple. The head of the fish is taken in the left hand of the workman, and with a knife held in the right hand he cuts a slice, longitudinally, from each side of the body, leaving the head and vertebræ to be thrown away, or, occasionally, to be pressed for oil. The slivers (pronounced *slyvers*) are salted and packed in barrels. The knife used is of a peculiar shape and is called a "slivering knife." The operation of slivering is shown in Plates XXII and XXIII.

The preparation of mackerel bait.

202. The use of menhaden bait for mackerel-fishing was inaugurated in 1835 or 1840; the bait is ground up into a mush and salted, to be used

* Third Report Commissioner Marine and Fisheries, 1871, p. 312.

† Third Report Department Marine and Fisheries, 1871, p. 342.

as a "toll-bait," and to be thrown over the side of the smack to attract the school to the surface and to keep it alongside; this is called "chumming up the fish," and the bait is called "chum" or "stosh." To prepare it for use the "slivers" are passed through a "bait-mill," which is a machine like a farmer's feed-cutter; the fish are thrown into the hopper, from which the fish pass between a roller armed with small knives in rows, and a series of similar knives arranged along a board which slopes toward the bottom. The bait is usually ground at night, by the watch on deck; when the vessel has no "bait-mill," the fish are cut up with a hatchet or scalded with boiling water in a tub. Bait-mills were first introduced about the year 1824. In fishing for mackerel, one man throws over the bait while the rest ply their lines. "Toll-bait" is also used by the smacks, which use purse-seines and drift-nets, to attract the fish to the surface.

The use of menhaden bait in the coast fisheries.

203. Menhaden bait is also used in the coast fisheries for sea-bass, on the "bull-tows" or "trot-lines," and in the eel and lobster pots. They are not much in favor for the latter use, however, for the oil of the fish is thought to permeate the flesh of the lobster, imparting to it an unpleasant flavor.

Extent of bait-fishery in New England.

204. Captain Babson, of Gloucester, whose account of the bait-fishery of Cape Ann is quoted elsewhere, and to whom I am indebted for much other valuable information, informs me that there were over 60,000 barrels of "round fish" taken in his district in 1873. Vessels belonging to the companies of the Maine Oil and Guano Association sold in 1873 for bait 2,977 barrels; in 1874, 10,400; in 1877, 10,795. From the bait fisheries about Marblehead, in the vicinity of Provincetown, 1,000 to 2,000 barrels were taken for bait in 1873, according to Mr. Loring. At Chatham, for the past five years, the average catch has been about 5,000 barrels, a large portion of which are sold to the George's Bank codfish vessels. Nothing has been heard from the bait fisheries about Nantucket, which are, however, quite unimportant.

A large part of the fish taken at Martha's Vineyard are used for bait; in 1873 there were 5,000 barrels according to Jason Luce & Co.

At Gloucester, according to Mr. Babson, the 60,000 round barrels of fish make 20,000 barrels of "slivers," worth \$4 per barrel to the producer. At Marblehead, it averages \$1 per barrel for fresh and \$6 for salt; at Chatham, \$1.50 fresh; at Nantucket, 50 cents to 75 cents, and at Martha's Vineyard 50 cents, as I am told. In Narragansett Bay, according to Mr. J. M. K. Southwick, bait sold in 1871 for \$1 and \$1.50.

Bait-fishery in Merrimac River and Salem Harbor.

205. Fisheries of some importance are carried on at the mouth of the Merrimac River. The menhaden thus obtained are used chiefly to sup-

ply the Cape Ann fishing fleet with bait, although they are salted for food to a considerable extent. Ten seines and about seventy men are engaged in this fishery during its continuance, which is usually about one month—from the middle of June to the middle of July. The seines are 100 to 200 yards long and 5 to 8 fathoms deep, requiring 6 to 8 men to manage them. The boats from which they are worked are light scows, about 25 feet in length, and 8 feet in breadth of beam. The seine is set from the stern of the scow, and is worked from the shore by means of long warps.

Capt. Moses Pettingell, of Newburyport, to whom I am indebted for the above facts, tells me that the seine-gangs have occasionally taken 2,000 barrels of fish in a single day.

Boston and Gloucester vessels come to anchor at the mouth of the river and wait for their supplies of bait. At one time in 1877 there were 25 fishing schooners waiting. Captain Pettingell estimates that 500 supplies of bait of from 10 to 60 barrels are sold annually by the Merrimac seine-gangs.

The regular price of fresh bait for the past ten years has been \$1 per barrel. Probably 1,000 barrels of slivered fish were prepared in 1876; these sold for \$5 per barrel. Captain Pettingell estimates the annual catch for 1876 at 2,000 barrels to a boat, making an aggregate catch of 20,000 barrels, or perhaps 6,600,000 fish. The returns are probably not far from \$20,000 in a good season.

The following table is from the Report of the Commissioners of Inland Fisheries for 1877 (p. 65). It is possibly not complete :

TABLE.—Seine fishery at mouth of the Merrimac.

Name.	Menhaden.
E. Thurlow.....	} 2,013,675
R. Pierce.....	
B. M. Perkins.....	
W. H. H. Perkins.....	
N. Lattime.....	
B. Stevens.....	

A similar fishery, though of much less extent, is carried on by Gloucester vessels in Salem Harbor. There being no considerable body of fresh water, the schools are small and are easily dispersed. July 15, 1877, I observed six or seven gangs busily plying their seines opposite The Willows. After a day or two the menhaden were driven away, and the fishing ceased until the following week, when they returned and were soon followed by the same boats.

An estimate of the total consumption of menhaden bait.

206. It is not practicable to make, from the data to which I have access, any very accurate estimate of the total quantity of menhaden

bait used in one year. I have given below a number of estimates for individual ports or fisheries; 60,000 round barrels are thus accounted for. I do not hesitate to estimate the total consumption for 1877 at 80,000 barrels, or 26,000,000 of fish.

Consumption by the George's Banks fleet.

207. The George's Banks cod fleet is owned entirely in Gloucester. There are about 130 vessels, making usually one trip every twenty days. When they can get slivered menhaden they carry no other bait. Early in the summer they go to the Vineyard Sound for their bait, where they buy it from the pounds; later they are able to buy it from Gloucester and Newburyport seines. Each vessel carries about 40 round barrels of menhaden, iced. Mr. Joseph O. Proctor estimates the annual number of trips made with this bait at 600. This gives a total amount of 24,000 round barrels, or about 8,000,000 of fish; 24,000 round barrels are equivalent to 8,000 barrels of slivered fish.

Ten years ago, according to the estimate of the same gentleman, the "Georgiamen" did not carry menhaden bait on so many trips, nor did they carry so much. He estimates 300 trips, at 30 barrels each, giving an aggregate of 9,000 round barrels, or about 3,000,000 fish.

Consumption by the Grand Banks fleet.

208. Mr. Proctor estimates that the Grand Bank cod vessels of Gloucester use in all about 600 barrels of slivered menhaden bait.

Major Low's statement of the outfit of the schooner "Madam Roland,"* copied from the trip-book, shows that she was supplied with 5 barrels of pogie slivers, at \$8 per barrel, making \$40; and 5 barrels of slack-salted clams, at \$11, making \$55.† His model table, to show the cost of a new schooner fitted at Gloucester, 1875, for a four months' trip to the Grand Banks for codfish and halibut, with 14 hands, estimates for 12,000 pogies or herring, at \$100.‡

Consumption by the mackerel line-fishermen.

209. Each mackerel-vessel engaged in line-fishing consumes during the course of the season about 20 barrels of salted menhaden slivers. In 1867, when the entire fleet fished with hooks, the amount consumed by Gloucester alone amounted, by Mr. Proctor's estimate, to 6,500 barrels, and the total consumption in the United States of mackerel bait must have exceeded 25,000 barrels. In 1877 the purse-seiners are in a large majority. The whole amount consumed by a seining-vessel does not exceed 5 or 6 barrels in a season. Gloucester had in 1877 about 60 "mackerel-hookers," using about 2,400 barrels of slivers, while its seining-fleet used about 2,000 barrels more.

* Sailed for the Grand Banks August 26, 1873; arrived at Gloucester October 10, 1873; time absent, one month fourteen days; gross stock, \$2,758.27.

† *Ibid.*, p. 362.

‡ *Ibid.*, p. 368.

Capt. Sylvanus Smith, of Gloucester, stated to the Halifax Commission that a vessel fitting out for a four months' trip to the Gulf of St. Lawrence would need to be supplied with 40 barrels of pogie bait, worth \$6 a barrel, making \$240, and 10 barrels of salt clams, worth \$8 a barrel, making \$80.*

Major Low's statement, copied from the trip-book of the schooner Oliver Eldridge,† shows that she fitted out with 55 barrels of slivered pogies, at \$6.50 a barrel, making \$357.50, and 7 barrels of clams, at \$6, making \$42.‡

The amount of these outfits is much greater than that upon which the above estimate was made.

The entire amount used in the mackerel fishery in 1877 probably did not exceed 8,000 or 9,000 barrels of slivers, or 24,000 to 27,000 barrels of "round fish."

Consumption by the Connecticut smacks.

210. There are seven Connecticut smacks fishing for the flounder (*Chaenopsetta ocellaris*) in Long Island and Block Island Sounds. Five of these hail from Noank, one from Mystic, and one from New London. Captain Ashby tells me that these smacks average one trip every four or five days for five months (May to September inclusive). They use only menhaden bait; about one barrel each trip, or perhaps 150 barrels in the season.

Sixteen Noank and four New London smacks fish for sea-bass. Each carries two or three barrels of menhaden bait each trip, making an aggregate annual amount of about 1,000 barrels.

Consumption by the New York halibut fleet.

211. The New York halibut fleet of 11 sails, owned at Noank, New London, and Greenport, uses only menhaden bait, which is iced fresh in the vessels' holds. Each vessel carries from 6,000 to 10,000 fish each trip. Each vessel makes five or six trips. The aggregate number of menhaden thus used is perhaps 480,000, or 1,400 barrels. The usual price is \$4 a thousand.

Annual sale of bait by the Maine manufacturers.

212. The Menhaden Oil and Guano Manufacturing Association of Maine sold for bait:

	Barrels of fish.
In 1873.....	2, 977
In 1874.....	10, 400
In 1875.....	10, 752
In 1876.....	8, 432
In 1877.....	10, 795

* Proceedings Halifax Commission, 1877, Appendix L, p. 334.

† Which sailed for the Bay of St. Lawrence August 5, 1875 (absent 2 months and 28 days), arrived at Gloucester November 2, 1875, stocking \$1,771.83, or 224 barrels of mess mackerel.

‡ *Ibid.*, p. 334.

The Connecticut method of icing bait.

213. A peculiar method of preserving the unsalted menhaden is made use of on board of the Connecticut halibut-catchers. The fish, after being very carefully cleaned and eviscerated, are packed with pounded ice in bins holding about 125 cubic feet (about 5 feet in each dimension). A ground-layer of ice-blocks 12 inches thick is first laid, then a tier of fish consisting of two layers and about 4 inches thick, then a layer of 4 inches of pounded ice, and so on until the bin is filled, after which its sides are packed with pounded ice and covered with canvas. Seven to ten thousand fish are thus stowed in one bin. The stowing having been completed, the fish and ice freeze together in a solid mass, which is left untouched until the fishing-banks are reached.

Their supply of bait being thus secured, the vessels are never obliged to make harbor in search of a new supply. They often catch their fare upon La Have or Brown's Bank, and return home without having anchored. The bait is good for three weeks. Captain Ashby assures me that he has used it on the thirty-third day.

The Cape Ann method of icing bait.

214. On board the Gloucester vessels the menhaden are not eviscerated, nor are they packed with so much care; consequently they never last more than three weeks. Since twenty-four hours or more are usually occupied on both outward and home voyages, there is only a short time left for which the supply of bait can be counted upon. If by any means this time could be doubled, an important advantage would be acquired. Vessels would often be able to complete their fares on the eastern banks without going to Newfoundland for bait. Does the Connecticut method fulfill this requirement? Captain Hurlbert, one of the most experienced fishermen of Gloucester, says no. He claims that neither cod nor halibut will bite well at a fish which has had its blood removed. He says that a half-decayed fish, with the blood still in it, is better bait than a perfectly sweet one kept by cleaning it. He says, still further, that Gloucester fishermen formerly followed this method, but that it was abandoned many years ago, as early as 1866.

The comparative value of various methods of icing.

215. The comparative value of the different methods of preserving bait was discussed by Professor Baird in his testimony before the Halifax Commission, which is quoted:

"Question. Now will you state what observation you have made respecting the method of preserving fresh bait from the start all the voyage through?—Answer. As a general rule it is now preserved either by salting or freezing. Of course they keep it as long as it will remain without spoiling, and when you have to carry it beyond that time either ice it or salt it. Salting, of course, is a very simple process, but it alters

materially the texture and taste to such a degree that fish or other bait that under certain circumstances is highly prized by the fish is looked upon with a great deal of indifference when salted. Now, there are special methods of preserving the fish or bait by some chemical preparation, which preserves the fish without giving the saline taste. There are preparations by means of which oysters or clams or fish can be kept in solutions for six months without getting any appreciable taste, and without involving the slightest degree of deterioration or destruction. One process submitted to the group of judges, of whom I was chairman, was exhibited by an experimenter, who placed a jar of oysters in our room prepared in that way. I think about the 1st of August those were placed in our room, and they were kept there until the middle of September, for six weeks during the hottest portion of the Centennial summer, and that was hot enough. At the end of that time we mustered up courage to pass judgment upon this preparation, and we tasted these oysters and could not find them affected. We would have preferred absolutely fresh oysters, but there was nothing repugnant to the sensibilities, and I believe we consumed the entire jar. And we gave the exhibitor, without any question, an award for an admirable new method. That man is now using that process on a very large scale in New York for the preservation of fish of all kinds, and he claims he can keep them any length of time and allow them to be used as fresh fish quite easily. I don't suppose any fisherman ever thought of using any preservative except salt.

“Q. That is entirely experimental?—A. It is experimental, but it promises very well. Now, borax is one of the substances that will preserve animal matter a great deal better than salt, and without changing the texture. Acetic acid is another preparation, or citric acid will keep fish a long time without any change of the quality, and by soaking it in fresh water for a little while the slightly acidulated taste will be removed. I don't believe a cod will know the difference between a clam preserved in that way and a fresh clam.

“Q. Now, about ice. We know a good deal has been done in the way of preserving bait in ice. How far has that got?—A. It is a very crude and clumsy contrivance. They generally break up the ice into pieces about the size of pebble stones, or larger; then simply stratify the bait or fish with this ice, layer and layer about, until you fill up a certain depth or distance. The result is that if the bait can be kept two weeks in that method it is doing very well. They generally get a period of preservability of two weeks. The ice is continually melting and continually saturating the bait or fish with water, and a very slow process of decomposition or disorganization goes on until the fish becomes musty, flabby, and tasteless, unfit for the food of man or beast.

“Q. Well, there is a newer method of preservation, is there not?—A. There is a better method than using ice. The method described by the Noank witness, by using what is equivalent to snow, allows the water

to run off or to be sucked up as by a sponge. The mass being porous prevents the fish from becoming musty. But the coming methods of preserving bait are what is called the dry-air process and the hard-freezing process. In the dry-air process you have your ice in large solid cakes in the upper part of the refrigerator and your substance to be preserved in the bottom. By a particular mode of adjusting the connection between the upper chamber and the lower there is a constant circulation of air, by means of which all the moisture of the air is continually being condensed on the ice, leaving that which envelopes the bait or fish perfectly dry. Fish or any other animal substance will keep almost indefinitely in perfectly dry air about 40° or 45° , which can be attained very readily by means of this dry-air apparatus. I had an instance of that in the case of a refrigerator filled with peaches, grapes, salmon, a leg of mutton, and some beefsteaks, with a great variety of other substances. At the end of four months in midsummer, in the Agricultural Building, these were in a perfectly sound and prepossessing condition. No one would have hesitated one moment to eat the beefsteaks, and one might be very glad of the chance at times to have it cooked. This refrigerator has been used between San Francisco and New York, and between Chicago and New York, where the trip has occupied a week or ten days, and they are now used on a very large scale, tons upon tons of grapes and pears being sent from San Francisco by this means. I had a cargo of fish-eggs brought from California to Chicago in a perfect condition. Another method is the hard-frozen process. You use a freezing mixture of salt and ice powdered fine, this mixture producing a temperature of twenty degrees above zero, which can be kept up just as long as occasion requires by keeping up the supply of ice and salt.

“Q. How big is the refrigerator?—A. There is no limit to the size that may be used. They are made of enormous size for the purpose of preserving salmon, and in New York they keep all kinds of fish. I have been in and seen a cord of codfish, a cord of salmon, a cord of Spanish mackerel, and other fish piled up just like cord-wood, dry, hard, and firm, and retaining its qualities for an indefinite time.

“Q. Well, can fish or animals be kept for an unlimited period if frozen in that way?—A. You may keep fish or animals hard dried frozen for a thousand years or ten thousand years perfectly well, and be assured there will be no change.

“Q. Have geologists or paleontologists satisfied themselves of that by actual cases of the preservation of animal substances for a long period?—A. Yes; we have perfectly satisfactory evidence of that. About fifty years ago the carcass of a mammoth, frozen, was washed out from the gravel of the river Lena, I think, one of the rivers of Siberia, and was in such perfect preservation that the flesh was served as food for the dogs of the natives for over six months. Mr. Adams, a St. Petersburg merchant, came along on a trading expedition, and found it nearly con-

sumed, and bought what was left of it for the St. Petersburg Academy of Science—the skeleton and some portion of the flesh—which were preserved first in salt and afterwards in alcohol. Well, we know the period of time that must have elapsed since the mammoth lived in the arctic circle must be very long. We know we can talk with perfect safety of ten thousand years. The geological estimate of it is anywhere from fifty to a hundred thousand years; we cannot tell. There is no unit of measure; we know it must have been some hundreds of thousands, and probably it would have remained in the same condition as much longer.

“Q. Now, to come to a practical question, is this a mere matter of theory or of possible use? For instance, could this method be adapted to the preservation of bait for three or four months if necessary?—A. The only question of course is as to the extent. There is no question at all that bait of any kind can be kept indefinitely by that process. I do not think there would be the slightest difficulty in building a refrigerator on any ordinary fishing-vessel, cod or halibut, or other fishing-vessel, that should keep with perfect ease all the bait necessary for a long voyage. I have made some inquiries as to the amount of ice, and I am informed by Mr. Blackford, of New York, who is one of the largest operators of this mode, that to keep a room ten feet each way, or a thousand cubic feet, at a temperature of 20° above zero would require about 2,000 pounds of ice and two bushels of salt per week. With that he thinks it could be done without any difficulty. Well, an ordinary vessel would require about seventy-five barrels of bait, an ordinary trawling vessel. That would occupy a bulk something less than 600 feet, so that probably four and a half tons of ice a month would keep that fish. And it must be remembered that his estimate was for keeping fish in midsummer in New York. The fishing-vessels would require a smaller expenditure of ice, as these vessels would be surrounded by a colder temperature. A stock of ten to twenty tons would, in all probability, be amply sufficient both to replace the waste by melting and to preserve the bait.”*

39.—CONFLICTS BETWEEN BAIT FISHERMEN AND OTHERS.

Early feuds.

216. Some jealousy has naturally arisen at times between the bait-fishermen and the manufacturers, as is shown by the following extract from Professor Johnston's “History of the Towns of Bristol and Bremen, in the State of Maine.”

A special branch of the fishing business has of late been undertaken quite largely here (in Bristol), as at other places on the New England coast, called the “porgey fishery.” The fish are taken in seines, usually several miles from the coast, and are used for the oil they produce, and for manure.

* Proceedings Halifax Commission, Appendix L, p. 457.

These fish, the common menhaden of the coast, have been caught for use as bait in the cod-fishery from the earliest times; and at first the new branch of industry, in which such immense quantities are consumed, was viewed by the old fishermen with no little suspicion, as likely to interfere with the important and older branch of the fishing business by depriving them of bait. Some riots were at least threatened, and one oil factory was actually destroyed, as was believed, by the old fishermen, or at their instigation; but the opposition has ceased, and the general opinion seems to be that it is best to foster such an extensive branch of business, giving profitable employment for a part of the season, as this does, to so many men, even though it may be attended by some disadvantages, which in the end may prove more imaginary than real.*

The present aspects of the conflict in Maine.

217. In 1877 and 1878 a determined effort was made by the Maine line-fishermen to secure the passage of a legislative act forbidding the use of seines near the shores. Their claim was that the present methods employed in the fishery interfered with their legitimate privilege of catching menhaden for bait, and that their tendency was to drive away all other fishes as well, and to destroy the fisheries.

To this movement the manufacturers made strenuous opposition, claiming that the menhaden fishery is practically inexhaustible; that the habits of the species have not been changed by the fishery, and that so far from making it difficult to obtain bait the large fishery made it easier, capturing it in great masses and selling it to the fishermen in any desired quantity cheaper than they could obtain it for themselves. Mr. Maddock's report, which has frequently been mentioned, was prepared at the wish of the Maine manufacturers as an argument to be presented to the legislature on their behalf. All the questions involved have been elsewhere discussed. It seems very unlikely that any legislature will at present interfere with so extensive an interest as that of the menhaden oil manufacturers.†

40.—MENHADEN BAIT AS AN ARTICLE OF COMMERCE, AND THE CONSIDERATION OF ITS VALUE BY THE HALIFAX COMMISSION OF 1877.

The export of bait to the Dominion.

218. In the section relating to the value of the menhaden as a bait-fish (paragraphs 186-190), allusion was made to its extensive exportation for use in the fisheries of the Dominion of Canada.

The evidence of several witnesses was quoted to prove that menha-

* A History of the Towns of Bristol and Bremen in the State of Maine, including the Pemaquid Settlement. By John Johnston, LL. D., a native of Bristol, and Professor Emeritus of Natural Science in the Wesleyan University, Middletown, Conn., and Cor. Mem. of the Maine Historical Society. Albany, N. Y. Joel Munsell. 1873. 8vo. pp. 524. p. 460.

† See paragraph 156.

den bait was preferred to any other kind by the provincial fishermen. I am told that a considerable number of the vessels of the New England fleet fishing in the Gulf of St. Lawrence are accustomed to carry partial cargoes of salted menhaden to sell in the Straits of Canso. I have been unable to obtain any satisfactory statistics of this exporting trade. This is doubtless due to the fact that every mackerel vessel carries twenty barrels or more of salt slivered fish, and there being no law requiring their entry in the custom-house or for reporting sales after the return of the vessel, no one has the data upon which to found an estimate. More than 5,000 barrels of slivered menhaden, worth more than \$30,000, were probably carried to Dominion waters during the past season. Many vessels doubtless expended all the bait which they carried; many others sold their surplusage to the provincial mackerelmen. I should hardly venture to estimate the amount of these sales at more than \$8,000 or \$10,000, and very possibly they are even less extensive.

The claim of the English Government.

219. The subject of the alleged trade in menhaden bait was referred to frequently in the course of the proceedings of the Halifax Commission of 1877. The subject was first introduced by the English counsel in the "Case of Her Majesty's Government," * as follows:

"The question of bait must now be considered, as some importance may, perhaps, be attached by the United States to the supposed advantages derived in this respect by British subjects. It might appear at first sight that the privilege of resorting to the inshores of the Eastern States to procure bait for mackerel-fishing was of practical use. Menhaden are said to be found only in the United States waters, and are used extensively in the mackerel-fishing, which is often successfully pursued with this description of bait, especially by its use for feeding and attracting the shoals. It is, however, by no means indispensable; other fish-baits, plentiful in British waters, are quite as successfully used in this particular kind of fishing business, and very generally in other branches, both of deep-sea and inshore fishing, as, for example, fresh herrings, alewives, capelin, sandlaunce, smelts, squids, clams, and other small fishes caught chiefly with seines close in shore. British fishermen can thus find sufficient bait at home, and can purchase from American dealers any quantities they require much cheaper than by making voyages to United States waters in order to catch it for themselves. It is a remarkable fact that for six years past American fishermen have bought from Canadians more herring bait alone than all the menhaden bait imported into Canada during the same period. The menhaden bait itself can also be bred and restored to places in the Bay of Fundy, on the western coast of Nova Scotia, where it existed up to the time of its local extermination."

* Proceedings of the Halifax Commission, Appendix A, p. 28.

And again: "It is notorious that the supply both of food and bait fishes has become alarmingly scarce along the United States coast. At Gloucester alone some thirty vessels are engaged during about six months in each year catching menhaden for bait. They sell about \$100,000 worth annually, and, by catching them immoderately in nets and wears for supplying bait and to furnish the oil mills, they are rapidly exterminating them. The Massachusetts Fishery Commissioners, in their report for 1872, state that 'it takes many hands working in many ways to catch bait enough for our fishing fleet, which may easily be understood when it is remembered that each George's man takes fifteen or twenty barrels for a trip, and that each mackereler lays in from 75 to 120 barrels, or even more than that.' One of the principal modes for the capture of bait and other fishes on the New England coast is by fixed traps or pounds on the shore. By means of these, herrings, alewives, and menhaden are caught as bait for the sea-fishery, besides merchantable fish for the markets, and the coarser kinds for the supply of the oil factories. There are upward of sixty of these factories now in operation on the New England coast. The capital invested in them approaches \$3,000,000. They employ 1,197 men, 383 sailing vessels, and 29 steamers, besides numerous other boats. The fish material which they consume yearly is enormous, computed at about 1,191,100 barrels, requiring whole fishes to the number of about 300,000,000. These modes of fishing for menhaden and other bait are, furthermore, such as to preclude strangers from participating in them without exceeding the terms of the treaty; and even without this difficulty it must be apparent that such extensive native enterprises would bar the competition and suffice to ensure the virtual exclusion of foreigners."

The reply of the agent of the United States.

220. In the "Answer on behalf of the United States of America to the case of Her Britannic Majesty's Government,"* Judge Foster, states: "Off the American coast are found exclusively the menhaden or porgies, by far the best bait for mackerel."

This is well stated by Sir John MacDonald (in a debate in the Dominion Parliament, May 3, 1872), who says:

"It is also true that, in American waters, the favorite bait to catch the mackerel is found, and it is so much the favorite bait that one fishing vessel having this bait on board would draw a whole school of mackerel in the very face of vessels having an inferior bait. Now, the value of the privilege of entering American waters for catching that bait is very great. If Canadian fishermen were excluded from American waters by any combination among American fishermen or by any act of Congress, they would be deprived of getting a single ounce of the bait. American fishermen might combine for that object, or a law might be passed by Congress forbidding the exportation of menhaden; but, by the provision

* Proceedings of the Halifax Commission, Appendix B, pp. 18, 19.

made in the treaty, Canadian fishermen are allowed to enter into American waters to procure the bait, and the consequence of that is, that no such combination can exist, and Canadians can purchase the bait, and be able to fish on equal terms with the Americans."

These statements were based upon the Canadian official reports previously published, which say :

"For mackerel, the Americans use 'pogies' and clams, chopped fine, as bait. The 'pogies' are found only on the coast of the United States, and, when imported into the Dominion, cost about \$6 per barrel.

"The bait with which the Americans are supplied is far superior to any which can be secured in this country, to which may be attributed in a great measure the success of the Americans previously to the recent restrictions, although even now the local fishermen complain that they have no chance while an American schooner is fishing near them."*

"The menhaden fishery has within ten years grown into an immense business. Formerly they were taken only for bait, and were either ground in hand-mills, for mackerel, or used in what is called "slivers" for codfish bait. There is now a large fleet of steamers and sailing-vessels engaged in this fishery. Large factories have been erected on shore for extracting the oil. As these fish are not valuable until they are fat, which is in August and September, they are not much taken in their spawning time; and they will not therefore be exterminated. They are caught solely with seines, near the shore, their food being a kind of marine seed which floats upon the waters; consequently they will not take the hook. This fishery is one of the most profitable of all the fisheries, the oil being used for tanning and currying, extensively at home, and being exported in large quantities. The refuse of the fish, after being pressed, is used for manufacturing guano or fish phosphate, and is very valuable as a fertilizer. This fishery is purely an American fishery, no menhaden ever being found north of the coast of Maine. It is entirely an inshore fishery, the fish being taken within two miles from the shore."

The reply of Her Britannic Majesty's Government.

221. The "Reply on behalf of Her Britannic Majesty's Government to the Answer of the United States of America" responds :

"The Answer (pp. 18 and 19) lays much stress on the importance to Canadian fishermen of the menhaden bait-fishery on the coast of the New England States. The menhaden is here represented to be the best bait for mackerel, and is said to inhabit exclusively the American coast. An entirely fictitious value has been attached to this fishery. British fishermen do not frequent United States waters for the purpose of catching bait of any kind, or for any other purposes connected with fishing, consequently the privilege of entering those waters to catch menhaden is of no practical value. Any bait of that description which they may require may be purchased as an article of commerce.

* Annual report of the Department of Marine and Fisheries for the year ending June, 1870, pp. 312, 342.

"There are not now, nor have there ever been, treaty stipulations to prevent British fishermen from entering American waters to buy bait, if they prefer to do so. As a matter of fact, whatever menhaden bait British fishermen use is either purchased from American dealers or from Canadian traders, who import and keep it for sale like any other merchandise. Reference is made in the Answer to the possible contingency of legislation prohibiting the export or sale of menhaden-bait, the implied consequence being a serious disadvantage to Canadian fishermen in prosecuting the mackerel fishery. It would, in such contingency, be necessary to use other baits equally good, or resort to some other method of fishing, such as that described at page 10, enabling the fishermen to dispense with bait. Moreover, it is well known that menhaden are now caught in the open sea, many miles distant from the American coast. The Answer asserts, at page 19, that 'it is entirely an inshore fishery.' It can be proved that menhaden are chiefly caught off shore, frequently 'out of sight of land.' "

Mr. S. L. Boardman, of Augusta, Me., in an interesting report to the State Board of Agriculture, of which he is secretary, published in 1875, at page 60, says:

"Parties engaged in taking menhaden now go off ten or twenty miles from shore, whereas they formerly fished near the coast, and they now find the best and 'most profitable fishing at that distance.' This fish is included among the shore fishes described by Prof. S. F. Baird as having suffered 'an alarming decrease' along the inshores of the United States, owing partly to excessive fishing throughout their spawning time in order to supply the oil-factories."

Chapter 5 of the Answer deals with "the specific benefits which the treaty directs the Commission to regard in its comparison and adjustment of equivalents." The admission of British subjects to United States fishing grounds has been dealt with at length in the third chapter of the Case. There is nothing in the Answer on this subject calling for any reply excepting the statement at page 20, that Dominion fishermen "have in the United States waters to-day over 30 vessels equipped for seining, which in company with the American fleet are sweeping the shores of New England." Leaving out of question the "American fleet," which has nothing whatever to do with the matter, the correctness of the statement is directly challenged in so far as it implies that these 30 vessels or any of them are British bottoms, owned by Dominion fishermen; and the United States is hereby called upon to produce evidence in its support.

References in the testimony and affidavits.

222. In the testimony and affidavits presented by the United States counsel,* referred to in the biography of the menhaden appended to this memoir and quoted to some extent in paragraphs 188-189, are many

* Proceedings of the Halifax Commission, Appendices L and M.

allusions to the value of menhaden bait. In the series of statistical tables filed* is given a statement, prepared by the writer, of the annual product of the menhaden fisheries. In the speeches of counsel during the session of the Commission very little attention was paid to the menhaden.

•
Mr. Dana's remarks in his argument.

223. Mr. Dana remarked in his closing argument:†

"We need not catch our mackerel bait any more than our cod bait, within the three-mile limit. On the contrary the best mackerel bait in the world is the menhaden, which we bring from New England. All admit that. The British witnesses say they would use it, were it not that it is too costly. They have to buy it from American vessels, and they betake themselves to an inferior kind of bait when they cannot afford to buy the best from us."

224. Few comments are needed upon these statements.

(1) While other fish than the menhaden *may* be used as bait, the latter is preferred by mackerel fishermen generally. (See quotations from affidavits of Nova Scotian fishermen quoted above, 186-190, and the depositions of numerous American fishermen before the Commission referred to in the Bibliography of the Species, Appendix C.)

(2) For the period of six years past, referred to in the comparison of the sales of menhaden bait and herring bait, the mackerel fisheries in Canadian waters have been far below their usual importance, and there has been no large demand for menhaden bait. The bank cod-fishery has been as successful as usual and the demand for herring bait undiminished. Moreover a large proportion of the frozen herring exported to the United States are consumed as food, not as bait.

(3) The claim that the menhaden are being rapidly exterminated is discussed above in paragraphs 151-156.

(4) The criticism by the British counsel of the statement that menhaden are not taken at a distance from the shore is well sustained.

(5) The very extraordinary statement that menhaden can be bred and restored to their former haunts in the waters of Nova Scotia may be met by the statement that there is no evidence that the species was ever other than an accidental visitor to those waters, that none have been seen there for the past twenty-five years, that the present eastern limit of the geographical range of the species is forty or fifty miles west of—

M.—THE MANUFACTURE OF OIL AND GUANO.

41.—A HISTORY OF THE OIL MANUFACTURE.

The claims of Maine to the discovery of menhaden oil.

225. The manufacture of menhaden oil has been prosecuted for a few years only. Several individuals claim the honor of having been first to

* *Ibid.*, Appendix O.

† Appendix J, p. 78.

discover its value. About the year 1850 Mrs. John Bartlett, of Blue Hill, near Mount Desert, Me., while boiling some fish for her chickens noticed a thin scum of oil upon the surface of the water. Some of this she bottled, and when on a visit to Boston soon after carried samples to Mr. E. B. Phillips, one of the leading oil merchants of that city, who encouraged her to bring more. The following year the Bartlett family industriously plied their gill-nets and sent to market thirteen barrels of oil, for which they were paid at the rate of \$11 per barrel, in all \$143.*

Mr. Phillips gave them further encouragement, furnishing nets and large kettles, which they set up out of doors in brick frames, for trying out the fish. It was thought that much oil was thrown away with the refuse fish or scrap, and the idea of pressing this scrap was suggested. This was at first accomplished by pressing it in a common iron kettle with a heavy cover and a long beam for a lever; afterward by placing it under the weight of heavy rocks, in barrels and tubs perforated with auger holes. Mr. Phillips subsequently fitted out some fifty parties on the coast of Maine with presses of the model known as the "screw and lever press."

The claims of Connecticut and New York.

226. Others claim to have manufactured oil about the same time.† It is said that as early as 1850 or 1852 there was an establishment for the manufacture of white-fish oil near old Fort Hale, New Haven Harbor. I am informed that Elisha Morgan, of Poquannock Bridge, Conn., made oil from bony fish previous to the year 1850. He owned seines with which he caught fish to be spread upon land fresh. When he could not sell all his fish to the farmers he extracted their oil by boiling them.

Whether the value of the article and the methods of manufacture were first brought to notice in Maine or not, the people of that State were slow to improve their opportunities and the trade first assumed its importance on the shores of Long Island Sound. Whether the fisherman's wife of Blue Hill is the sole discoverer of the properties of menhaden oil is not evident; perhaps the facts were also known to others. At any rate the tradition of the Bartlett family is not current on Long Island. In the year 1850, according to Captain Sisson, D. D. Wells and

* As this account is somewhat different from those hitherto published, I give the story in the words of Mr. E. B. Phillips himself: "In about 1850 I was in the fish-oil business in Boston. An elderly lady by the name of Bartlett, from Blue Hill, Me., came into my store with a sample of oil, which she had skimmed from the kettle in boiling menhaden for her hens. She told me that the fish were abundant all summer near the shore, and I promised \$11 per barrel for all she could produce. Her husband and sons made thirteen barrels the first year, and the following year one hundred barrels."

† The manufacture of oil and of artificial guano from fishes has long been practiced in France, where the fish called Merlan (*Gadus merlangus*) is employed for the purpose, yielding 1½ to 2 per cent. of oil. In France the fish cake remaining after the extraction of oil is dried at a steam heat and is then ground fine and packed in air-tight casks for sale as manure.

his son Henry E. Wells started the first factory in the vicinity of Greenport, using steam for making oil and scrap. "At that time there were some few pots (whalemen's try-pots) used by other parties in boiling the fish in water and making a very imperfect oil and scrap, but were not very successful. The first oil made by D. D. Wells & Son was very black, impure, full of fleshy matter, and had a very offensive smell. It did not come much into use, and for a long time the profits of the business were small; but by persistent effort in perfecting machinery the quality of the oil was so much improved as to come into general use for certain purposes, such as painting, tanning, manufacture of rope, and adulterating other oils. The scrap was also very much improved by grinding and drying, pulverizing, &c., so that during the war the business was quite remunerative. At that time quite a number of factories were established and for a time the business was somewhat overdone, which caused some to abandon it altogether, and others to consolidate; and at the present time there are ten factories in operation, doing a fair business, giving employment to a large number of people and bringing up a hardy race of boatmen and sailors."

Professor Baird, visiting this region in 1857, wrote: "Quite recently several establishments have been erected on Long Island for the manufacture of oil from the moss-bunker. The fish, as brought in, are chopped up and boiled, and the oil skimmed off; a heavy pressure on the residuum expresses the remaining oil, and what is left is still useful as a manure. The oil finds a ready market. It has been estimated that a single fish will furnish enough oil to saturate a surface of paper eighteen inches square."*

Notwithstanding the fact that the coast of Maine was adapted for much more profitable prosecution of the oil manufacture, nothing of importance was done there until 1865. The trade grew rapidly for about four years, but has not augmented considerably since 1870. Twenty factories were built in a short period, fourteen of which are still in operation, though several have failed from the too sudden expansion of their business. As has been seen, the only points at which the trade has any statistical importance are within a limited area on the coast of Maine, on Narragansett Bay, and on Long Island Sound. At other points, one or two factories absorb the whole business; they are but half worked, and many of them have been abandoned. I am informed that efforts are being made to establish factories on Cape Cod and on the coast of South Carolina.

Great improvement has been made in the processes of refining and clarifying the oil, and the clear, yellow, nearly odorless substance now produced is vastly different from the article manufactured in early days.

The process of extracting oil by steam was patented in 1852 or 1853 by Wm. D. Hall, of Wallingford, Conn., the originator of the Quinipiac Fertilizer Company. Mr. Hall was engaged in bone-boiling and tallow-

* Fishes of the New Jersey Coast, 1855, p. 33.

rendering at Wallingford ; he had a load of white-fish carted to his factory from Branford, 16 miles distant. At night, after his men had left the factory, he cleaned out his tallow tanks, steamed his fish, and extracted the oil ; his experiment was satisfactory and the process was immediately patented. The priority of his discovery is challenged by Mr. D. D. Wells, of Greenport, who claims to have used the process for some years previous to this time. After securing his patents, Mr. Hall visited numerous "pot works," which had by this time been established, for the purpose of introducing his new methods. At this time he also secured a patent for the process of drying fish scraps upon platforms by solar heat.

The inception of the oil business in Maine.

227. The first factory in Maine was built by a company from Rhode Island, in 1864, at Blue Hill, and the next by another company from Rhode Island, at Bristol, on John's Bay, the same season. Operations being successful, home parties in Booth Bay, Bristol, Bremen, and Southport went into the business. In the spring of 1866 eleven factories were built, all using steam. This may be regarded as the beginning of the industry in Maine on a scale at all in ratio with its capabilities.

Erection of factories in Maine.

228. The following table, taken from Mr. Maddock's pamphlet, gives the dates at which the factories of the several firms named were built, and the cost of the same. The titles of some have since been changed by incorporation with others, change of ownership, &c. Of the eleven factories specified before as built in 1866, one has been burned, and two absorbed by now existing corporations.

Date of building of factories in Maine.

Names.	When built.	Where.	Cost of buildings and equipment.
Gallup & Holmes.....	1866	Booth Bay.....	\$15,000
Gallup, Morgan & Co.....	1866	do.....	15,000
Suffolk Oil Works.....	1866	do.....	30,000
Kenniston, Cobb & Co.....	1867	do.....	15,000
White Wine Brook Company.....	1867	do.....	12,000
Maddock's Factory.....	1866	Southport (now Booth Bay).....	25,000
Bristol Oil Works.....	1866	Bremen.....	10,000
Albert Gray & Co.....	1870	do.....	12,000
Round Pond Company.....	1866	Bristol.....	15,000
L. Brightman & Sons.....	1866	do.....	15,000
Pemaquid Works.....	1869	do.....	15,000
Jos. Church & Co. Works.....	1871	do.....	40,000
Loud's Island Works.....	1873	do.....	6,000
Brown's Cove Works.....	1874	do.....	10,000
Tnithill, French & Co.....	1868	do.....	10,000
Wells & Co.....	1864	do.....	12,000
Fowler, Foote & Co.....	1874	do.....	2,000
South Saint George Factory.....	1876	South Saint George.....	1,500
Total.....			260,500

The original investment of \$260,500 has been increased, as shown by the report for 1877, to \$1,083,612.

42.—THE LOCATIONS OF THE OIL FACTORIES.

Factories in Maine.

229. The oil and guano factories are located chiefly on the coasts of Maine, Rhode Island, Connecticut, and Long Island, at the localities already designated as being most frequented by large schools of menhaden.

In 1877 there were on the coast of Maine fourteen establishments of sufficient importance to be represented in the Maine Oil and Guano Association, all but two of them in good financial standing. I am indebted to Messrs. Church, Pryer and Maddocks for the detailed list given below, including those not now in operation. There are, besides, several small factories of no great statistical importance.

On Muscongus Sound, near Round Pond, are six factories owned by THE BRISTOL OIL WORKS, with two presses; ALBERT GRAY & Co., with two presses; JOSEPH CHURCH & Co., with four presses; the ROUND POND OIL COMPANY, not now in operation; LEONARD BRIGHTMAN & Co., now bankrupt; the BROWN'S COVE COMPANY (not operated in 1877), and the LOUD'S ISLAND OIL COMPANY.

On John's Bay, Liniken's Bay, and in that vicinity are ten, owned by the PEMAQUID OIL COMPANY, with three presses; WELLS & Co., with two presses; TUTHILL, FRENCH & Co., with two presses; FOWLER, FOOTE & Co.; the SUFFOLK OIL COMPANY, with two presses; GALLUP & HOLMES, with two presses; GALLUP, MORGAN & Co., with two presses; KENNISTON, COBB & Co., with two presses (not now in operation); LUTHER MADDOKS; the WHITE WINE BROOK COMPANY.

There is also a factory at Brooklin owned by ROBERT A. FRIEND, and the SOUTH SAINT GEORGE OIL WORKS, at South Saint George.

The GEORGE W. MILES COMPANY, of Milford, Conn., have for several years operated their ship, the Alabama, with two presses, in John's Bay.

There have also been within a few years factories at Blue Hill, owned by CONARY & Co.; in Brooklin, owned by G. ALLEN & Co.; in Brookville, owned by E. C. CHATTO & Co.; in Belfast, owned by J. C. CONDON and by J. C. MAYO. The first is known to be abandoned, and no returns have been received from the others since 1873.

A considerable amount of oil is also tried out by individuals who carry on a small business of this description in connection with other occupations. The amount thus produced in 1874 was estimated by Mr. Eben B. Phillips at from 50,000 to 75,000 gallons.

Factories in Massachusetts.

230. In Massachusetts there are no important factories; the CAPE COD OIL WORKS, at Provincetown, and the NORTH AMERICAN OIL WORKS, at Wellfleet, try out a small quantity of menhaden oil annually, but this is merely incidental, their chief source of supply being bodies of stranded blackfish and porpoises.

A small quantity of oil is tried out by the fishermen on Cape Cod, chiefly, perhaps, from the refuse remaining after the fish have been "slivered" for bait.

Near Wood's Holl, Mass., is the factory of the PACIFIC GUANO COMPANY, which at the time of its establishment in 1863 was engaged largely in the fisheries and oil pressing, but has now discontinued this branch of the business. At Dartmouth is the factory of ERSKINE PIERCE, and at Fall River that of JOB T. WILSON, which is referred to below in the Narragansett Bay list.

Factories in Rhode Island.

231. In Narragansett Bay are thirteen factories, specified in the following list kindly furnished by Mr. Church:

THE ATLANTIC OIL AND GUANO COMPANY, operating 3 presses.
 JOB T. WILSON & Co., at Fall River, Mass., operating 3 presses.
 WM. J. BRIGHTMAN & Co., at Tiverton, R. I., operating 2 presses.
 ISAAC BROWN & Co., at Tiverton, operating 2 presses, good condition.
 CHARLES COOK, at Tiverton Four Corners, operating 2 presses.
 AMASSA SIMMONS, at Tiverton Four Corners, operating 1 press.
 ISAAC G. WHITE, at Tiverton Four Corners, operating 2 presses.
 BENJ. MANCHESTER, at Tiverton Four Corners, operating 1 press.
 ANTHONY MANCHESTER, at Tiverton, operating 1 press.
 OTIS H. ALMY & Co., at Tiverton Four Corners, operating 1 press.
 NARRAGANSETT OIL AND GUANO COMPANY, operating 2 presses.
 JAMES MANCHESTER, at Tiverton, operating 1 press.
 THOMAS F. GRAY, operating 2 presses.

Mr. Pryer gives the names of the following manufacturers not included in Mr. Church's list. Some of them are doubtless concerned in the titled companies already mentioned:

JOHN SOUTHWORTH, Portsmouth, R. I.
 W. H. H. HOWLAND, Portsmouth, R. I.
 WILCOX MANCHESTER, Tiverton Four Corners, R. I.

Rhode Island has no factories west of Narragansett Bay.

Factories in Connecticut.

232. Another group of factories is located between the eastern boundary of Connecticut and the Connecticut River. In 1877 there were five in number, as follows:

GURDON S. ALLYN & Co., on Mason's Island, between Stonington and Noank, running three gangs.

LEANDER WILCOX & Co. (formerly J. GREEN & Co.), on Mint Head, also east of Noank, running two gangs.

WALEY & Co., at Poquonnock Bridge, east of the Thames River, running one gang.

QUINNIPIAC FERTILIZER COMPANY, on Pine Island, Groton, at the mouth of the Thames River, running four gangs.

LUCE BROTHERS, at Niantic.

Several other factories were formerly operated in this vicinity, namely, the QUIAMBOG OIL COMPANY, on Noyes Neck (one gang), burnt down in 1876; the GARDNER OIL COMPANY and REUBEN CHAPMAN'S WORKS on Mason's Island (one gang), abandoned.

Luce Brothers, of Niantic, formerly had a floating factory built on the hull of the old railway ferry-boat "Union." In 1876 a new factory was built by them and the floating factory was abandoned.

West of the Connecticut River the factories are not numerous. I learn the names of the following companies: ¹

SALT ISLAND OIL COMPANY, at Westbrook, owned by J. L. Stokes and others, not now running.

J. H. BISHOP, at Madison.

FOWLER & COLBURN, at Guilford.

E. R. KELSEY, at Branford, supplied by weir fisheries.

WELCH'S POINT OIL COMPANY, at Milford.

THE GEORGE W. MILES CO., at Milford, owning a factory on the shore and a floating factory, the "Alabama," built upon the hull of an old man-of-war. This is usually operated on the coast of Maine and is referred to in the list of Maine factories. In 1878 it is the intention of Mr. Miles to work it on the coast of New Jersey.

Factories in New York.

233. At the eastern end of Long Island is another cluster of oil works. The following list was furnished by Capt. Benjamin H. Sisson in 1873:

D. D. WELLS AND SONS.

HAWKINS BROTHERS.

H. CORWIN & CO.

FITHIAN & HORTON.

BENJAMIN PAYNE, GREEN & CO.

B. C. CARTWRIGHT & CO.

VAIL, BENJAMIN & CO.

THE STERLING CO.

Also two floating factories the "Falcon," 2,500 tons, Capt. Geo. F. Tuthill; the "Ranger," 1,500 tons, Capt. F. Frank Price.

Many have since been established and in Mr. Pryers' list (Appendix H) the following manufacturing firms are enumerated, fifteen in number:

W. Y. FITHIAN & CO., at Napeague (Amagansett).

GREEN BROTHERS, at Amagansett.

JOSEPH D. PARSONS, at Springs.

G. H. PAYNE, at Deep Hole, Easthampton.

HAWKINS BROTHERS, at Shelter Island.

B. C. CARTWRIGHT, at Shelter Island.

HENRY E. WELLS, at Greenport.

GEORGE F. TUTHILL, at Greenport.

T. F. PRICE, at Greenport.

J. NORRISON RAYNOR, at Greenport.

W. H. H. GLOVER, at Southold.

G. H. CLARK, at East Marion.

W. W. WARNER, at Good Ground.

W. C. RAYNOR, at Westhampton.

NELSON BURNETT, at Southampton.

On the Great South Bay are four factories:

J. S. HAVENS, at Patchogue.

SMITH, GREEN & Co., at Sayville.

SMITH & YARRINGTON, at Sayville.

SOUTH BAY OIL COMPANY, at Sayville.

On the south shore of Long Island, at Barren Island, a few miles east of the entrance to New York Harbor, at the mouth of Jamaica Bay, are four factories, owned by—

SEAMAN JONES & Co.

HAWKINS BROTHERS.

FRANK SWIFT.*

BARREN ISLAND MANUFACTURING COMPANY.

In these four factories, according to Mr. Seaman Jones, about \$200,000 capital is invested, half of it on shore and half in "sailing rigs."

Factories in New Jersey.

234. In 1873 there were said to be one or two oil factories in Southern New Jersey, at Somers Point and Little and Great Egg Harbors. The fisheries in this vicinity are not vigorously prosecuted, and in 1873 the factory at Atlantic City had already been deserted. Mr. Miles informs me that he proposes to operate his floating factory, the Alabama, in New Jersey waters during the coming season of 1878.

According to Mr. Pryer the following factories were in existence in 1877:

GRIFFIN & VAIL, at Port Monmouth.

CAPT. C. DOUGHTY, at Somers Point.

MORRIS & FIFIELD, at Somers Point.

JAMES E. OTIS, at Tuckerton.

CYRUS N. SMITH, at Tuckerton.

Factories on Chesapeake Bay.

235. I am informed by Mr. H. L. Dudley that there are four factories in the Chesapeake Bay between Norfolk and Baltimore. I have not learned the names and locations of all these establishments. One, "THE VIRGINIA OIL AND GUANO COMPANY," of which Mr. O. E. Maltby, of Norfolk, is president and Mr. Dudley agent, is located at New Point Comfort. A second is owned by WILLIAM D. HALL, of Willenbeck,

* Better known by the name of its former owner, Mr. Koon.

Lancaster County, Va., who was formerly connected with the Quinnipiac Fertilizer Company. A third was the MANOKIN OIL WORKS, owned in 1873 by CROCKETT & Co., and a fourth on Tangier Island, owned in 1873 by FORD, AVERY & Co. The Manokin Works are said to be in Pocomoke Bay. A factory was operated near Norfolk in 1872 by Mr. Fitzgerald, but this has since been destroyed by fire.

F. H. HARKER has a factory at Hampton, Va.

Factories on the southern coast.

236. South of Cape Henry there are no factories now in operation. Mr. W. F. Hatch, keeper of Body's Island light, North Carolina, gave the names of the following factories in that vicinity which had at that time already been abandoned :

EXCELSIOR WORKS (cost \$30,000).

CHURCH & Co. (cost \$5,000).

ADAMS & Co. (cost \$5,000).

There is still another abandoned factory near Beaufort, N. C.

At Charleston, S. C., are the works of the Pacific Guano Company, which consumes immense quantities of menhaden scrap. This is however brought from the water by the vessels which carry on their return trip a supply of South Carolina phosphates for the other factory owned by the company, at Wood's Holl, Mass.

A company in Charleston has a charter for establishing a menhaden fishery at the mouth of Charleston Harbor.—(*C. C. Leslie.*)

43.—METHODS OF OIL MANUFACTURE.

The principles involved.

237. The manufacture of menhaden oil is simple in the extreme, consisting of three processes: boiling the fish, pressing, and clarifying the expressed oil. The apparatus absolutely needful is correspondingly free from complication, consisting, for the first process, of a cooking vessel; for the second, a press, and for the third a shallow vat or tank. These were used twenty-five years ago by Mrs. Bartlett, the manufacturer of the first menhaden oil, who produced an article little inferior to the best now in the market. Very few patents for improved methods of manufacture have been granted: Mr. W. D. Hall's patent for steam-rendering is the most important. The principal changes have been in the introduction of labor-saving appliances, which enable manufacturers to carry on their business with the smallest possible force of workmen. Steam is of course an important auxiliary in handling the fish and in working the presses, and is also used to great advantage in heating the cooking-tanks, as well as for pumping the water and oil. The hydraulic press has replaced the old fashioned screw-press in most of the larger establishments, and the size, shape, and arrangement of the bleaching vats, as well as the methods of drawing and pumping the oil from one to the other, have been perfected.

Processes employed in manufacture.

238. The process of oil-making at the larger works is essentially as follows: The fish are conveyed to the upper story of the factory on wooden tramways in cars containing about twenty barrels each, and are dumped into large reservoirs from which the cooking-tanks are replenished from time to time, or are emptied directly into the cooking-tanks, which are filled to the depth of six inches with sea-water. From fifty to seventy-five barrels are placed in each cooking-tank, and then steam is turned on and they are boiled for half an hour or more. In this way about two-thirds of the oil is separated; the remainder is expressed by means of the hydraulic presses, under a pressure of 50 to 150 tons or less; the fish having been placed in circular curbs of half-inch iron, perforated with holes an eighth of an inch in diameter, each curb having a capacity of three to ten barrels. The oil mixed with water is now run into the "drawing-off tanks" while it is still hot, and is passed through several of them, the water separating and sinking to the bottom. The oil is now drawn off into a "settling-tank" of four or five thousand gallons capacity, where it remains a few hours to allow impurities to sink to the bottom. Finally, it is pumped into "bleaching-tanks" (of which Judson, Tarr & Co. have five, each containing four thousand gallons), where it becomes clearer and whiter in the rays of the sun, and after one or two weeks' exposure is ready for shipment.

Processes employed in refining.

239. Boardman & Atkins make the following statements about processes of refining:

"The oil and water running together into the receivers, separate, by the oil rising to the top, whence it can be drawn or skimmed off. Great pains must be taken to separate the oil from the water before the impurities contained in the latter begin to ferment, for if this happens the quality of the oil suffers much. Moreover, in what appears at first to be pure oil there is a variable amount of finely divided fleshy substance that must be allowed to settle, as it will after a while, and the clarified oil drawn off before putrefaction sets in. In order to effect the separation, the oil is commonly passed through a number of settling-vats, and a portion of the impurities deposited in each, and finally before barreling, the oil is, if practicable, exposed some hours to the sunlight in a broad, shallow tank. If all these processes are successfully carried through, the oil is light-colored, sweet, and of prime quality; but if it is exposed at any time to the influence of putrefying animal matter, it becomes dark and 'strong.' The very strongest of oil is made from the 'gurry' or settlings of the oil, after fermentation, by steaming or boiling it over.

"It naturally happens that every manufacturer makes several grades of oil, of very different quality, of which the best is very sweet, fine oil, bringing ten cents a gallon more than a strong article. Notwithstand-

ing this fact, it is said to be the common practice of dealers to pour all grades into the same vat, and this has led manufacturers to take less pains to keep them separate.

"It is a curious fact that oil made from early fish is not so good as that made later. It is called 'weak,' and brings in market five cents per gallon less."*

Gurry oil is sold for one-third less than the other grades.

Perhaps the most satisfactory way of indicating the processes now in use will be to describe three or four of the principal factories in detail.

The factory of The George W. Miles Company.

240. The factory of The George W. Miles Company at Milford, Conn., illustrated in Plate XXV, is said to have been the first one built after the model now universally followed, with the cooking-tanks and oil-presses upon the second floor of the building.

When the fishing fleet comes in, the fish are hoisted from the holds of the vessels into cars, in which they are carried over an inclined tramway to the upper story of the factory building. Here they are turned into tanks, twenty thousand fish in each, and cooked by steam-power. Then the water is drawn off and the cooked fish are placed in perforated iron curbs, which are so arranged upon railways that they can be pushed under a hydraulic press. Each curb-load of fish is subjected to a pressure of sixty or seventy tons, by which the greater part of the oil is extracted. The scrap is then dropped into the cellar below.

The ship "Alabama" is owned by the same firm. It is used as an oil factory, and is usually more productive than the stationary works owned by the same firm. It is illustrated in Plate XXX. For several seasons it has been taken to Maine during the fishing season, where it is usually stationed near South Bristol. It is the intention of the owners to take it to the coast of New Jersey for the season of 1878.

The factory of Judson Tarr & Co.

241. Messrs. Judson Tarr & Co., of Rockport, Mass., kindly furnished the following account of their factory in Pemaquid (Bristol), Me., as it was in 1873:

"The size of the main factory is 30 by 40 feet, with 16-foot posts; the building is two stories high, the upper story being used for cooking and pressing the fish, the lower as an oil-room and for storing fish-scrap. The engine-house adjoining the factory measures 20 feet by 30, with 10-foot posts, and contains three horizontal boilers each of sixty-five horse power. In the upper story of the factory are eleven round wooden cooking-tanks 12 feet in diameter and 4 feet deep; each tank has steam-pipes in its bottom, perforated with small holes to allow the escape of the steam; there are also three hydraulic presses, each with pressure of one hundred and fifty tons, and a small engine of ten-horse power.

* Op. Cit., p. 27.

Connected with the factory are two wharves, the longer 150 by 50 feet in dimensions, the shorter 40 by 80. At the end of the long wharf is placed, on posts 10 feet high, a tank capable of containing 4,000 barrels of menhaden. This tank is sometimes completely filled when all the steamers have discharged their loads after a successful day's fishing. On the wharf is an engine of twelve-horse power connected with three drums, all or either of which may be used; when in full blast one thousand barrels can be transferred from the steamers to the tank in an hour, the process being precisely similar to that of unloading coal from barges.

Also, on the premises of the company, are a main scrap-house, 100 feet by 60, with 15-foot posts, and blacksmith's, cooper's, and carpenter's shops, as well as a boarding-house and stable, all used in connection with the business.

The amount invested in buildings and machinery is between \$75,000 and \$80,000, and in steamers and fishing gear, such as seines, small boats, &c., is about \$60,000 additional.

The utmost capacity of the factory is 2,000 barrels per diem. About thirty-five men are employed at the factory.

The factory of Joseph Church & Co.

242. The Muscongus Oil Works, on Muscongus Point, Maine, the largest in the United States, were visited by Professor Baird in September, 1873. These works were erected in 1872, and are carried on by Joseph Church & Co., of Tiverton, R. I.* The main building is 161 feet long and 40 feet wide. The lower portion is the receptacle of the chum, where about 1,800 tons were in store on the 25th of September, three cargoes of about 190 tons each having been sent away during the year. The establishment is larger than any other in the United States, and is well appointed in every particular, capable of working up more than 3,000 barrels of fish in a day. About forty-five men were employed at these works, and about 5,500 tierces of 40 gallons of oil each had been manufactured during the year. These works are now much more extensive, employing during the past season (1874) seventy fishermen and seventy factory hands, with four steamers and three sailing-vessels. They have invested in buildings and machinery \$65,000, and in fishing gear \$55,000. During the season 138,000 barrels or about thirty-four millions of menhaden were caught; 200 barrels were sold for bait, and of the remaining 136,000 barrels they manufactured 450,000 gallons (11,250 tierces) of oil and 4,000 tons of chum or guano.

The factory of Kenniston, Cobb & Co.

243. The establishment of Kenniston, Cobb & Co. is selected for description by Boardman and Atkins, who state that though not one of the largest, it is generally conceded to be a model of convenience and efficiency.

* Illustrated in Plate XXIX.

"The main floor of the factory stands a considerable height above the water. Here are all the steam tanks and the press, and in an adjoining building is the boiler and the principal engine. The tanks are of wood, 8 feet square and 4 feet deep, with a capacity of fifty-one barrels, with a board platform on which the fish rest, 4 inches above the bottom. Into the space between the platform and the bottom the steam is introduced. There are tanks arranged in two rows, between which runs the track leading from the landing. Another track passes by all the tanks and leads to the press. On this track run several cylindrical curbs made of wood and iron. The press is hydraulic, and is worked by steam. On a lower level than the steam tanks are series of receptacles for the oil and water, that are brought to them by conductors leading from the tanks and press. Under the main floor is the scrap-house, into which the scrap is dumped through a scuttle in the floor. The track that runs between the rows of tanks leads down a steep incline to the landing, where there is another engine, and an elevator to take the fish out of the boats. The elevator delivers the fish into a hopper that holds fifty barrels, and from this they are drawn into a car that holds seventeen barrels, so that the unloading of the boat may go on without intermission while the car is carrying its load up to the tanks. The car is drawn up by the engine on the landing, and dumps its load into either of the tanks at pleasure.

"Preparation for the fish is made by filling the tank a foot deep with water and steaming it until hot. The fish are at first steamed hard from forty to sixty minutes, then punched and broken up. After simmering for five hours longer the free water and oil are drawn off, and then, if possible, the broken fish stand draining and cooling for several hours. At last they are pitched into the curbs, run under the press, and subjected to a pressure which is gradually brought up to seventy-five tons. This wrings out all the water and oil that it is practicable to extract, and the cheese is now dropped into the scrap-house to remain until the following autumn or winter."*

The factory at Napeague, N. Y.

244. In the *American Agriculturist* for December, 1868, p. 452, was published a description of the factory at the entrance to Napeague Harbor, near Montauk Point. In Plates XXVI and XXVII are reproduced the illustrations of the factory and its interior arrangements. The following description of the factory was published at the same time:

"The fish are taken to the factory's dock. At the factory the fish are measured either in cars or boxes, and are drawn upon the railway to the tanks, where they are thrown into water, and a full head of steam turned on into the bottom of the tank, which contains some sixteen to eighteen thousand fish. After thirty minutes' cooking, the water is drained off, and a man getting into the tank fills the curbs, which are circular, and

* *Op. cit.*, p. 27.

formed of strong wooden slats, bound and lined with heavy iron. These are rolled under a solid, stationary head, fitting closely the inside of the curb, and against which the fish are pressed, as the curb is slowly but powerfully raised by a hydraulic press. The oil and the water absorbed by the fish in boiling are pressed out through the slats and carried by leaders to the tanks in the shed by the side of the factory, where the oil-man skims, boils, and otherwise prepares it for barreling. As soon as the pressure is taken off, the curb slowly resumes its position on the railway, and is pushed to where a man stands ready to remove the cheese as it falls from the curb, upon the opening of its hinged bottom. This cheese or scrap-cake is ground to different degrees of fineness, to form the fish guano. This substance, being rich in ammonia-producing material, is used by some manufacturers of fertilizers to supply ammonia to phosphates that are deficient in that constituent."

The model of a factory in the National Museum.

245. A complete model of the oil-factory of Joseph Church & Co., at Round Pond, Me., was exhibited in the Department of Fisheries in the United States Government building at the Philadelphia Exhibition. It is now deposited in the United States National Museum.

The cost of an oil-factory.

246. The larger part of the cost of an oil factory consists in the machinery, as the buildings are always of wood, substantial but cheap. The amount invested in factories by different manufacturers appears to range from \$2,000 to \$65,000. The average amount invested in the fourteen factories of the Maine Association is \$22,600, but the general average will not probably exceed \$12,000 or \$15,000.

Mr. Church, of Tiverton, R. I., speaking of the establishments on Narragansett Bay, remarks that a factory ready for business, including buildings, tanks, boilers, hydraulic presses, oil-room, &c., of a capacity to cook and press 800 barrels (200,000) in a day, costs not far from \$14,000. A hydraulic press costs about \$1,200; in 1877, \$700.

Mr. Miles, of Milford, Conn., states that boilers cost from \$2,000 to \$4,000, hydraulic presses with curbs and fixtures \$2,000; engines, pumps, shafting, and pulleys, together with the necessary buildings, bring the cost of the factory to from \$10,000 to \$50,000.

Capt. B. H. Sisson, of Greenport, N. Y., estimates the cost of boilers, engine, piping, hydraulic press worked by steam, steam drying machines, and steam hoisting apparatus, to cost from \$10,000 to \$25,000 for each factory.

Mr. Dudley states that a factory running three or four gangs of fishermen costs from \$20,000 to \$30,000.

The capital invested in the factory is one-half of the whole amount. The fourteen establishments of the Maine Association had in 1874 \$316,000 in buildings and machinery and \$390,000 in "gear"; that is,

in steamers, sailing-vessels, small boats, and nets ; an average of \$27,800 to each for gear against \$22,600 for factory.

In Connecticut, according to Mr. Dudley, about the same proportion holds.

The total amount of capital invested in the several companies is given, by Mr. Jasper Pryer, as follows :

G. S. Allyn & Co	\$25,000 00
Wm. J. Brightman & Co	20,000 00
J. H. Bishop.....	9,000 00
Bristol Oil Works.....	35,000 00
Brown's Cove Company.....	23,000 00
Isaac Brown & Co.....	9,000 00
Barren Island Manufacturing Company.....	17,500 00
Joseph Church & Co. (Rhode Island)	17,000 00
Do.....(Maine)	200,000 00
Charles Cook	18,000 00
G. H. Clark.....	500 00
Fowler, Foot & Co.....	42,000 00
Fowler & Colburn.....	47,000 00
W. Y. Fithian & Co.....	20,000 00
Robert A. Friend	5,500 00
Albert Gray & Co.....	55,000 00
Gallup & Holmes	70,000 00
Gallup, Morgan & Co.....	44,000 00
W. H. H. Howland.....	20,000 00
S. Jones & Co	30,000 00
Kenniston, Cobb & Co.....	25,000 00
E. R. Kelsey.....	8,000 00
Loud's Island Oil Company	25,000 00
Luce Bros.	50,000 00
Maddocks Oil Works	130,000 00
The George W. Miles Company (Maine)	59,000 00
Do.....(Connecticut)	45,000 00
Morris & Fifield.....	5,000 00
James Manchester	3,000 00
James E. Otis	11,000 00
Erskine Pierce	11,000 00
Quinnepiac Fertilizer Company	110,000 00
Round Pond Oil Works.....	42,000 00
Suffolk Oil Company	45,000 00
South Saint George Oil Works	37,000 00
Smith & Yarrington.....	15,000 00
Tuthill, French & Co.....	21,000 00
Griffin & Vail	10,000 00
Job F. Wilson	40,000 00

Waley & Co	\$15,000 00
Isaac G. White	35,000 00
Wells & Co.....	60,000 00
Leander Wilcox & Co	30,000 00
Cyrus W. Smith.....	7,000 00
Westbrook Oil Company	1,000 00
Eleven factories in Gardiner's Bay, N. Y.....	310,000 00

The total amount here specified is \$1,857,500. It should be noted that several companies are not reported.

Organization of the fishing gangs.

247. "In the early days of the business," says Mr. Dudley, "the manufacturers did not own the fishing-vessels, nor were they interested peculiarly in the fishery; they bought the fish from independent fishermen. This method was found unsatisfactory; the fishermen sold to the highest bidder, and the supply was uncertain. Of late years the company owns the vessels which supply it with fish. The crew work upon shares, as in other fisheries. In the settlement, at the end of the season, a sailing-vessel, with seine and gear, draws one-third of the net proceeds; a steamer, one-half; the remainder is divided by the crew, the captain receiving an ordinary share, in addition to which he is paid a salary by the company, either fixed or proportionate to the success of the season's work. It is not uncommon for a successful captain to receive a "bonus" of \$500, or sometimes \$1,000. In settling the season's account, the total catch is paid for at a rate proportionate to the yield of oil. In 1876, the Quinupiac Fertilizer Company paid \$1.25 per thousand. The company usually advances pay to the men to the extent of \$1 a thousand, and at the end of the season a final settlement is made. The crew of a sailing-vessel will average from \$35 to \$75 a month; the crew of a steamer somewhat more."

Advantages claimed for floating factories.

248. Floating factories are in use chiefly on Long Island Sound; in whose protected waters they operate to great advantage. They are now going out of use on account of the introduction of steamers. They are usually built upon the hull of some old vessel, and are towed from point to point, gathering the fish from the smacks and working them up into oil and guano as they move. Some of them are fitted up with machinery for very extensive manufacture. Two important objects are attained by the owners of floating factories: the objection to their business arising from the offensive odor is to a considerable extent removed; by following the movements of the fish time and expense are saved, for by bringing the factory to the fish they obviate the necessity of having a fleet of lighters to carry the fish to the factory, which might often require two or three days. There are five of these factories; one owned at Milford, Conn., and four at Greenport, N. Y.

Mr. Goodale's improved method.

249. I quote from Mr. Maddocks's excellent little report the following account of an improved process devised by Mr. Goodale:

"As now generally managed, the scrap remains in large heaps until shipped, in autumn or winter, to the points of manufacture into, or incorporation with, superphosphate. In this time a portion of the oil and water leaks away, so as to leave about 10 to 15 per cent. of the former, and 48 to 53 per cent. of the latter. The elimination of the water is an advantage, but the specified per cent. of oil is lost; and a portion of nitrogen is also lost, resulting from the partial decomposition of the mass, the formation and escape of ammonia. It were better, if practicable, to drive off the water at once upon withdrawal from the press, so as to prevent the loss in question.

"What has hitherto prevented the driving off of the water immediately by artificial heat has been the presence of so much *oil*, together with the gelatinous or gluey matter which is developed during the cooking, chiefly from the skins and bones. These render the process of drying the scrap a very difficult and tedious one, so much so that comparatively little has been put into market in that desirable form. The recent discovery of an easy and simple process for removing the larger part of the oil, and also at the same time the gelatinous hinderance to drying, gives promise of a speedy change in this respect.

"While pursuing investigations relative to utilizing the menhaden as a source of concentrated food, before referred to, Mr. S. L. Goodale, well known as a chemist as well as for his eminent services to the State as secretary of the board of agriculture, found, by thoroughly washing the scrap as it came from the press, with sufficient hot water and agitation, that the oil globules were liberated from their entanglements in the fleshy tissues, and also from the creamy mixture with the gluey matter into which they were forced by the pressing, so that the greater part of it could be readily recovered by draining and re-pressing; and also that after such washing the scrap would bear heavier pressure than at first without 'squirting.' By this easy process the oil product is largely increased, the scrap is left free from the gluey hinderance to drying, and contains less water to be dried out.

"It may appear strange that so simple a method should not have been discovered sooner, but such is the fact. Work had been done on both sides of it. Re-pressing had been tried, using extra strong curbs, with very powerful pressure, but it failed to give satisfactory results. Re-cooking had been resorted to, which resulted in injury to the oil, and in the development of an additional amount of the gelatinous matter. It is now seen that a simple thorough washing in hot water accomplishes the desired end with neither of these objectionable results. Scrap made by this process last August (1877), and dried in the open air, was lately analyzed at the agricultural experiment station of Connecticut, and the statement of the director, Prof. S. W. Johnson, of New Haven, shows

the proportion of moisture to be reduced to 11.45 per cent., or about one-fifth that contained in the scrap fresh from the press, and the proportion of oil to 4.65 per cent., thus proving that the content of oil in the *washed scrap as it came from the press* (before drying it) had been reduced to less than 2½ per cent. According to these figures, the proportion of oil hitherto lost is, by the new process, reduced from an average of, say, 15 per cent. of the weight of the scrap as it commonly issues from the press, to about 2 per cent.; the balance, say, 12 or 13 per cent., is saved. Let it be assumed, however, that only 10 per cent. can be realized in practice, and that the annual outturn of scrap from the factories of the Maine Association is only 40,000,000 pounds. This would give an annual saving of 4,000,000 pounds of oil, or 533,000 gallons, worth at current prices at market for 1877, 40 cents per gallon, \$213,200."

Proposed chemical methods.

250. Other methods of extracting the oil from fish scrap have been proposed, but their adaptability is not yet so certainly proved as to warrant their adoption by manufacturers.

The proposed plans involve the use of the fumes of benzine, or bisulphide of carbon, which are brought into contact with the fish in air-tight chambers. The oil is absorbed by these substances, and collects in tanks in the floors of the chambers. Any surplus of benzine or bisulphide of carbon which may remain in the oil is expelled by distillation.

The *naphtha* process for extracting the oil, remarks Mr. Maddocks, consists in subjecting the scrap, in an inclined iron cylinder, to the action of vapors of naphtha, which combine with the oil, and the latter in a state of solution filters away at the lower end of the cylinder. The naphtha is then recovered by evaporation. The process is slow, costly, and dangerous.

Proposed mechanical methods.

251. It has been suggested that a recently invented filter-press, the invention of Mr. John Bowling, is well adapted for the extraction of oil from the menhaden and the formation of the residue into cakes. It is probably too small for the extended operations of manufacturers, but may be very serviceable for the use of refiners. Mr. C. B. Norton, 25 Astor House, N. Y., is the American agent.

44.—VALUE OF FISH FOR MANUFACTURING PURPOSES.

Prices of fish at different seasons.

252. The price of fresh menhaden cannot be definitely stated, since it varies from week to week with the abundance and fatness of the fish and the needs of individual manufacturers.

Many factories rely entirely upon their own "gangs" for their supplies; some others buy the fish of the vessels engaged in the trade,

though this practice is less common than it formerly was. Still every factory buys fish in greater or less quantity, and the answers to question 47 of the circular are important in exhibiting the variations in abundance at different points on the coast. Perhaps it may not be amiss to quote fully from the letters, it being quite impossible to tabulate the facts.

Mr. William H. Sargent, of Castine, Me., says: "For four years past the average price has been 65 cents per round barrel.*"

Jason Luce & Co., of Menemsha Bight, estimate that menhaden average from 225 to 240 in a barrel.†

In the report of the committee on statistics from the United States Association for the meeting of 1875, the estimate was put at three barrels to the thousand fish, or 333 fish to the barrel.

Captain Tuthill estimates 22 cubic inches to each fish, Captain Sisson 21, making three and one-half barrels to the thousand. In Long Island Sound the fish are sold by the thousand; farther east, always by the barrel.

Mr. Condon, of Belfast, estimates the price for 1873 at 60 cents; Mr. G. B. Kenniston, of Booth Bay, at 75 cents, stating that in previous years the price has ranged from 50 cents to \$1.25. Mr. B. F. Brightman says that in 1872 and 1873 the average has been 65 cents, but that when oil was high they have brought \$1. Mr. J. Washburn, of Portland, estimates the price at \$1 for 1873; during the war, much higher. Mr. Eben B. Phillips estimates the price at from 60 to 70 cents in 1873, 56 in 1874, and about 60 in previous years. Fall fish, for trying, bring 40 to 50 cents in Wellfleet, Mass., according to Mr. Dill. At Nantucket, according to Mr. Reuben C. Kenny, the fish are worth from 50 to 75 cents as taken from the nets; only about half are used in the manufacture of oil.

Mr. Church gives the average price on Narragansett Bay at 40 cents, and to this correspond very nearly the estimates of the southern shore of Cape Cod and the Vineyard Sound, which find market for their menhaden at the Narragansett factories.

Captain Crandall, of Watch Hill, R. I., thinks \$2 to the thousand a fair estimate for 1873 and 1874. Captain Beebe, of Niantic, Conn., agrees with this, giving \$2.50 for previous years. Mr. R. E. Ingham, of Saybrook, says \$1.25 to \$2. Mr. Miles says that in 1873 the prices ranged from \$1 to \$2.50, according to the yield of oil. Mr. F. Lillington, of Shatford, puts it, for 1875, at from \$1.50 to \$2. Captain Sisson, of Greenport, says that in 1873 the price was \$2.25; in previous years, \$1.75; in 1874 the price was lower. Collector Havens, of Sag Harbor,

* A "round barrel" is a barrel of undressed fish, and weighs about 200 pounds. The number of fish in a barrel necessarily varies with their size. Estimates range from 180 to 280; but that made by Mr. Fairchild, at the meeting of the "United States Menhaden Oil and Guano Association," in 1874, is perhaps fair, putting four barrels to a thousand fish, or 250 fish to a barrel.

† Report United States Commission Fish and Fisheries, 1871-'72, p. 35.

N. Y., estimates it at 30 cents per barrel. In the vicinity of Atlantic City, N. J., M. A. G. Wolf gives the price at \$1.25 to the thousand; and Mr. Albert Morris, of Somers Point, at 39 cents per barrel (about \$1.50 to the thousand). Mr. Hance Lawson, of Cresfield, Md., states that the Chesapeake factories pay 15 cents per bushel.* Mr. Dudley says that in 1877 the average price in the Chesapeake was 50 cents a thousand.

Prices proportionate to amount of oil contained in fish.

253. These prices are simply those paid for fish used in the manufacture of oil and guano, the prices of those sold for bait or food being given under other heads. No satisfactory conclusions can be drawn from these statements, except the very general one that the fish are more valuable on the eastern than on the southern coast of New England; in Maine bringing from \$2.40 to \$3.20 to the thousand; on Long Island Sound, \$1 to \$2.25. As the expense of capture is necessarily as great in Southern as in Northern waters, we must seek the reason of the difference in price either in the methods of manufacture, the abundance of the fish, or in the intrinsic value of the fish for the purposes of the manufacturer.

Oil yield of Northern fish.

254. On the first arrival of the schools in Northern water the fish are thin and do not yield a large quantity of oil; but they rapidly gain until the time of their departure in fall, so that the late fishing is by far the most profitable. It is the general opinion of fishermen that Northern fish yield a larger proportionate amount of oil than Southern.

Mr. Sargent, of Castine, Me., says that three quarts of oil to the barrel is the smallest yield he has ever known from the first school, and six gallons the most from the last school. When the fish are very poor, about the 1st of June, it takes 250 to make one gallon of oil; when poor, in July, 200; when fat, in August, 150; when very fat, in October, 100. About one ton of scrap is obtained in making three barrels of oil. Mr. Condon states that when the fish arrive in the spring they will produce but one gallon to the barrel, while in October the yield is four or five gallons; the average for the season being three gallons. Mr. Friend states that the least yield, in June, is two quarts to the barrel; the greatest, in August, four gallons. Mr. Kenniston states that May fish yield three pints to the barrel; October fish, six gallons and one-half. These are no doubt intended as the extreme figures. The average yield is two and one-half gallons to the barrel, an estimate in which Mr. Brightman concurs, though placing the lowest at three quarts; the highest, in August and September, at four gallons. He estimates the yield of a ton of scrap at thirty to forty gallons, according to the season. Judson Tarr & Co. put the early fish at less than a gallon, the September fish at four gallons to the barrel. Mr. Babson thinks that the early

* About 50 cents per barrel, or \$2 to the thousand.

fish yield about a gallon, the last four gallons; an estimate in which he is confirmed by Mr. E. B. Phillips.

Mr. Erskine Pierce, of Dartmouth, Mass., states that in 1877 the average yield at his factory was $1\frac{1}{4}$ gallons to the barrel.

According to Mr. Church, the fish are fattest generally in the fall, though after a warm winter he has known them after first arrival to yield $2\frac{1}{2}$ gallons. After a cold winter the opposite is true; and he has seen them so poor in the summer that out of one hundred barrels of fish not a pint of oil could be extracted. The first 18,000 barrels taken by Church & Co., on the coast of Maine, in 1873, did not make over 14,000 gallons of oil (about three quarts to the barrel). On Narragansett Bay, in 1873, the yield was $1\frac{1}{2}$ gallons less than on the coast of Maine; on Long Island Sound, half a gallon.

Mr. Reuben Chapman informed me that at his factory, on Mason's Island, opposite Noank, Conn., the yield of early fish was sometimes as low as a gallon to the thousand, later in the season reaching fourteen or even eighteen gallons; which would be equivalent to five or six gallons to the barrel.

Mr. Maddocks, writing of the Maine fish, states: "The yield of oil sometimes doubles, per head, in thirty days after their coming. The fish taken on the coast of Maine yield a considerably larger supply of oil than those taken at points farther south, around Long Island, off the Jersey shore, &c. The amount of oil per barrel of fish is there about one gallon, against two and a half here, for the whole season in each case."

And again: "The amount of oil realized varies from one gallon per barrel of fish early in the season to four or five gallons in September. The scrap contains, on the average, as it comes from the press, 55 to 60 per cent. of its weight in water, and sometimes more. This is, of course, worthless for fertilizing purposes. It also contains from 12 to 20 per cent. of fat or oil, which is equally worthless for manure."

Mr. Dudley considers that the first taken in Long Island Sound yield, on an average, about 4 gallons to the thousand. At Pine Island it is somewhat greater; one season averaged $3\frac{1}{2}$, another $6\frac{1}{2}$. In 1877 the average to June 12 was 5 gallons; to November 1, 3 gallons. On November 1 the fat fish made their appearance, and the average has since doubtless greatly increased. There is usually an increase in the yield of oil after July 1, but since 1874 this has not been the case in Southern New England. Mr. Dudley has cooked fish which would not yield a quart of oil to the thousand. Again, in November, the yield has been 18 gallons. It is the opinion of Mr. Dudley that dark oil only is yielded by fish taken in brackish water; light oil by those taken outside.

The George W. Miles Company, of Milford, states that the largest amount made by them in one factory in any one year was in 1871, when they produced 100,000 in about fifty working days; the largest quantity in the shortest time was 21,000 gallons in seventy-two hours, or 7,000

gallons to each day of twenty-four hours. In 1872 they produced 60,000 gallons, and in 1873 105,000 gallons in their two factories, one factory not operating all the time on account of a pending lawsuit.

According to Capt. J. L. Stokes of the Salt Island Oil Company, the average yield of oil is four gallons to the thousand, 9,000 fish making a ton of scrap. Captain Beebe and Mr. Ingham put the highest for the region about the mouth of the Connecticut River at eight gallons, or perhaps three gallons or less to the barrel.

Mr. Miles writes: "All depends upon the quality of the fish, whether fat or poor. In July, August, and September we only get fish that come into the Sound to feed, and they fatten after they get here. If they are poor, we have the largest catch in June and July; if they are increasing in fat or yield of oil, we cannot capture them successfully until August and September. The fat fish in the Sound are usually wild and hard to take until late, perhaps owing to the fact that their food is plenty and low in the water. When the season is unusually dry, the fish are sure to be fat; but in a wet season they are found to be below the average in yield of oil. After the fish get here, if their food is plenty, they grow fat very fast. In the past season (1873), in May and June, one million of fish would make only 800 gallons; in August, the yield was from 8 to 10 gallons per thousand, and in September, 10 to 12."

At Greenport, in 1873, the average yield, on Captain Sisson's estimate, was $8\frac{1}{2}$ gallons to the thousand; the smallest yield, half a gallon in spring and late fall; the greatest, 22, in September and October; 8,000 fish make a ton of green scrap. Mr. Havens puts the lowest yield at one quart to the barrel, the highest at 4 gallons, an estimate much below Captain Sisson's, which would make over 6 gallons to the barrel.

Hawkins Bros. estimate the lowest yield at one gallon to the barrel in midsummer, and $4\frac{1}{2}$ in October and November, putting the average quantity of fish to the gallon at one-third of a barrel on Gardiner's Bay, one-half at Barren Island, and 85 gallons to a ton of scrap on Gardiner's Bay, 57 at the island.

At Atlantic City, N. J., according to Mr. A. G. Wolf, the average yield is 4 gallons to the thousand, the greatest in November, 11; a ton of scrap corresponding to 40 gallons of oil.

On Great Egg Harbor, states Mr. Morris, July fish yield one quart of oil to the barrel; those of October and November yielding 4 gallons. A gallon of oil is the average to each barrel of fish, and 45 gallons to a ton of scrap.

The yield to each barrel of fish was thus estimated by Rhode Island manufacturers in 1877: Joseph Church & Co. and W. H. H. Howland, 1 gallon; Charles Cook, Job T. Wilson, Isaac G. White, and James Manchester, $1\frac{1}{4}$ gallons; Isaac Brown & Co., $1\frac{1}{39}$; and William J. Brightman, $1\frac{1}{3}$.

Connecticut manufacturers are estimated as follows: The George W. Miles Company, $2\frac{3}{4}$ gallons to the thousand; Leander Wilcox & Co., 3

gallons; G. S. Allyn & Co., $3\frac{1}{2}$ gallons; Waley & Co. and Luce Brothers, $3\frac{1}{4}$ gallons; the Quinipiac Fertilizer Company, $3\frac{1}{2}$ gallons; J. H. Bishop, $3\frac{1}{2}$ gallons; and Fowler & Colburn, $3\frac{3}{4}$ gallons.

New York manufacturers are estimated as follows: The Barren Island Manufacturing Company, G. H. Clark, W. Y. Fithian & Co., $2\frac{1}{2}$ gallons to the thousand; Smith & Yarrington, $2\frac{3}{4}$ gallons; S. Jones & Co., $4\frac{1}{2}$ gallons; eleven factories in Gardiner's Bay, 3 gallons.

New Jersey manufacturers are estimated as follows: Morris & Fifield, 2 gallons to the thousand; James E. Otis, Griffen & Vail, Cyrus H. Smith, $2\frac{1}{2}$ gallons.

Maine manufacturers in 1877 were reported as follows: Albert Gray & Co., $1\frac{1}{2}$ gallons to the barrel; Gallup, Morgan & Co., $2\frac{9}{14}$ gallons; Fowler, Foot & Co., $2\frac{1}{8}$ gallons; Suffolk Oil Company, $2\frac{1}{4}$ gallons; R. A. Friend, $2\frac{1}{2}$ gallons; Gallup & Holmes, $2\frac{1}{2}$ gallons; Loud's Island Company, $2\frac{3}{4}$ gallons.

M. Maddocks declares that on the coast of Maine "one hundred and ninety-five pounds of fish make a barrel. One barrel yields about two and a half gallons of oil or eighteen and three-quarter pounds. One barrel yields about eighty pounds of chum or scrap."

Oil yield of Southern fish.

255. Mr. Kenniston makes the following statement: "Corresponding with the successive appearance of the menhaden from South to North there is a progressive improvement in size and fatness. When they arrive in Chesapeake Bay, in the spring, they are thin and lean, and appear to be sluggish and stupid, so that they are easily caught—can almost be taken out by the hand along the shore, which many of them follow closely. Between Virginia and Maine the increase in weight is thought to be one-third. In the fall the increase still continues, but the order of it is reversed, the fish appearing to grow larger the farther South they go, and on reaching Virginia again are twice as heavy as in the spring, and have so gained in strength, swiftness, and wariness that they are very hard to catch."*

Mr. Dudley tells me that from his experience of two years he knows that the first runs of fish in the Chesapeake are fat. This is in March and April.

Mr. A. C. Davis states that the June fish at Beaufort yield from $\frac{3}{4}$ to 1 gallon, those in October and November 4 to 5 gallons.

Mr. W. F. Hatsel, of Body's Island, states that the average yield is $1\frac{1}{2}$ gallons to the barrel, 75 gallons to the ton of scrap.

Comparison of yield in different localities.

256. These statements indicate in a general way that the yield of Northern is greater than that of Southern fish, though the disparity is not so

* Boardman and Atkins, op. cit., p. 6.

great in the latter part of the season. Mr. Davis' estimate for Beaufort is, however, not much below the average of the coast south of Maine, and it is quite possible that the apparent disparity of the yield on the Southern coast (of which we are not really entitled to judge with the meager returns before us) would be in part explained by differences in the modes of manufacture. Florida menhaden are many of them very fat in the winter season, and there is no apparent reason why the manufacture of oil and guano may not be successfully carried on on our Southern coast.

The official returns of manufacturers may add some additional facts in reference to the yield of fish in oil and guano and the comparative advantages of location.

The following table and statement, quoted from Mr. Maddocks, give a comparative view of the manufacture as carried on by the Maine Association and by all the rest of the United States for the year 1876, the latest for which the data are at hand for the whole country.

Locality.	No. of men.	No. of vessels.	No. of steamers.	Total capital.	Barrels fish used.	Gallons oil manufactured.	Tons crude guano manufactured.
Other States...	1, 629	291	3	\$1, 767, 000	826, 885	848, 727	29, 831
Maine.....	1, 129	29	43	983, 000	709, 000	2, 143, 273	21, 414

The most striking fact brought out in the comparison is that Maine realized, from 46 per cent. of the fish, 71 per cent. of the oil. To this it may be added that from the use of \$983,000 capital Maine turned out a total product of \$1,071,449 value, whereas the rest of the country realized \$637,600 from \$1,767,000.

45. STATISTICS OF THE MANUFACTURE OF OIL AND GUANO.

Returns for the State of Maine.

257. The number of gallons of oil produced at the factories of the Maine Association during the past five years is as given below :

1873	1, 204, 055
1874	1, 931, 037
1875	1, 514, 881
1876	2, 143, 273
1877	1, 166, 213
Total.....	7, 959, 459

Table showing average number of vessels employed in fisheries of Maine Association.

Name.	Address.	1873.	1874.	1875.	1876.	1877.
L. Brightman & Sons	Round Pond, Me.	5	3	3	2	-----
Judson, Tarr & Co.	Pemaquid, Me.	2	1	-----	-----	-----
Albert Gray & Co.	Round Pond, Me.	1	1	1	1	1
Jos. Church & Co.	do	2	3	2	2	2
Gallup, Morgan & Co.	East Boothbay, Me.	3	2	2	1	-----
W. A. Wells & Co.	South Bristol, Me.	2	2	1	-----	-----
Gallup & Holmes	East Boothbay, Me.	3	4	2	-----	-----
Kenniston, Cobb & Co.	Boothbay, Me.	4	5	5	4	-----
Atlantic Oil Company	do	6	3	-----	-----	-----
Round Pond Oil Works	Round Pond, Me.	3	6	3	4	4
Bristol Oil Works	do	-----	-----	2	2	-----
Suffolk Oil Works	do	5	4	-----	3	1
Loud's Island Oil Works	do	2	2	2	3	2
R. A. Friend	Brooklin, Me.	-----	1	-----	-----	-----
Tuthill & Co.	South Bristol, Me.	-----	-----	1	1	-----
J. G. Nickerson & Co.	Hodgdon's Mills, Me.	-----	-----	5	-----	-----
John Hastings	Round Pond, Me.	-----	-----	3	-----	-----
Fowler & Foote	South Bristol, Me.	-----	-----	-----	3	3
George W. Miles & Co.	do	-----	-----	2	-----	-----
Job T. Wilson	Blue Hill, Me.	-----	-----	-----	-----	-----
Pemaquid Oil Company	Pemaquid, Me.	-----	-----	-----	-----	-----
Brown's Cove Oil Company	Round Pond, Me.	-----	-----	-----	3	-----
Maddocks' Oil Works	Boothbay, Me.	-----	-----	-----	-----	-----
South Saint George Oil Works	South Saint George, Me.	-----	-----	-----	-----	-----

Table showing amount of capital employed by manufacturers of Maine Association.

Name.	Address.	1873.	1874.	1875.	1876.	1877.
L. Brightman & Sons	Round Pond, Me.	\$90,000	\$90,000	\$90,000	\$110,000	\$90,000
Judson, Tarr & Co.	Pemaquid, Me.	110,000	120,000	-----	-----	-----
Albert Gray & Co.	Round Pond, Me.	28,000	55,000	50,000	45,000	55,000
Jos. Church & Co.	do	120,000	120,000	145,000	155,000	200,000
Gallup, Morgan & Co.	East Boothbay, Me.	19,000	21,000	31,000	35,000	44,612
W. A. Wells & Co.	South Bristol, Me.	27,000	35,000	40,000	40,000	60,000
Gallup & Holmes	East Boothbay, Me.	22,000	25,000	50,000	51,000	70,000
Kenniston, Cobb & Co.	Boothbay, Me.	27,000	70,000	25,000	25,000	25,000
Atlantic Oil Company	do	65,000	100,000	140,000	135,000	-----
Round Pond Oil Works	Round Pond, Me.	16,000	18,000	20,000	12,000	21,000
Bristol Oil Works	do	28,000	20,000	22,000	16,000	35,000
Suffolk Oil Works	do	55,000	55,000	-----	80,000	45,000
Loud's Island Oil Works	do	6,500	8,000	8,000	8,000	25,000
R. A. Friend	Brooklin, Me.	-----	6,500	-----	-----	-----
Tuthill & Co.	South Bristol, Me.	-----	-----	28,000	38,000	42,000
J. G. Nickerson & Co.	Hodgdon's Mills, Me.	-----	-----	90,000	-----	-----
John Hastings	Round Pond, Me.	-----	-----	23,000	-----	-----
Fowler & Foote	South Bristol, Me.	-----	-----	36,000	48,000	42,000
George W. Miles & Co.	do	-----	-----	57,000	57,000	59,000
Job T. Wilson	Blue Hill, Me.	-----	-----	24,000	-----	-----
Pemaquid Oil Company	Pemaquid, Me.	-----	-----	-----	110,000	160,000
Brown's Cove Oil Company	Round Pond, Me.	-----	-----	-----	15,000	23,000
Maddocks' Oil Works	Boothbay, Me.	-----	-----	-----	-----	130,000
South Saint George Oil Works	South Saint George, Me.	-----	-----	-----	-----	37,000

Table showing average number of tons of crude guano produced by the manufacturers of Maine Association.

Name.	Address.	1873.	1874.	1875.	1876.	1877.
L. Brightman & Sons	Round Pond, Me.	1,500	2,600	2,500	1,450	-----
Judson, Tarr & Co.	Pemaquid, Me.	1,800	2,150	-----	-----	-----
Albert Gray & Co.	Round Pond, Me.	750	1,300	1,680	1,300	800
Jos. Church & Co.	do	2,100	4,000	4,500	6,000	5,400
Gallup, Morgan & Co.	East Boothbay, Me.	680	900	1,016	1,100	700
W. A. Wells & Co.	South Bristol, Me.	700	900	510	1,000	562
Gallup & Holmes	East Boothbay, Me.	470	790	900	1,230	1,500
Kenniston, Cobb & Co.	Boothbay, Me.	615	850	714	433	-----
Atlantic Oil Company	do	1,800	2,450	2,000	1,595	-----
Round Pond Oil Works	Round Pond, Me.	450	850	550	600	150
Bristol Oil Works	do	600	800	800	80	600
Suffolk Oil Works	do	1,300	950	-----	850	740
Loud's Island Oil Works	do	200	500	400	-----	275
R. A. Friend	Brooklin, Me.	-----	205	-----	-----	-----
Tuthill & Co.	South Bristol, Me.	-----	-----	500	825	800
J. G. Nickerson & Co.	Hodgdon's Mills, Me.	-----	-----	1,375	-----	-----
John Hastings	Round Pond, Me.	-----	-----	400	-----	-----
Fowler & Foote	South Bristol, Me.	-----	-----	450	825	562
George W. Miles & Co.	do	-----	-----	850	1,121	725
Job T. Wilson	Blue Hill, Me.	-----	-----	250	-----	-----
Pemaquid Oil Company	Pemaquid, Me.	-----	-----	-----	2,000	1,900
Brown's Cove Oil Company	Round Pond, Me.	-----	-----	-----	175	-----
Maddocks' Oil Works	Boothbay, Me.	-----	-----	-----	-----	1,600
South Saint George Oil Works	South Saint George, Me.	-----	-----	-----	-----	352

186 REPORT OF COMMISSIONER OF FISH AND FISHERIES.

Table showing average number of barrels of fish taken by fleet belonging to Maine Association.

Name.	Address.	1873.	1874.	1875.	1876.	1877.
L. Brightman & Sons	Round Pond, Me.	49,000	82,000	83,000	48,000	-----
Judson, Tarr & Co.	Pemaquid, Me.	61,000	67,000	-----	-----	-----
Albert Gray & Co.	Round Pond, Me.	25,000	46,000	53,000	45,000	27,000
Jos. Church & Co.	do	86,600	138,000	153,000	201,000	182,000
Gallup, Morgan & Co.	East Boothbay, Me.	22,000	29,472	29,545	34,763	23,760
W. A. Wells & Co.	South Bristol, Me.	22,913	30,000	28,000	30,000	19,200
Gallup & Holmes	East Boothbay, Me.	15,000	25,000	32,000	40,000	51,847
Kenniston, Cobb & Co.	Boothbay, Me.	18,000	28,339	21,323	14,474	-----
Atlantic Oil Company	do	43,600	64,000	56,000	51,878	-----
Round Pond Oil Works	Round Pond, Me.	16,500	27,000	18,000	22,000	5,500
Bristol Oil Works	do	22,600	33,000	24,000	25,653	22,500
Suffolk Oil Works	do	41,000	29,000	-----	26,916	22,200
Loud's Island Oil Works	do	8,000	15,000	12,300	13,000	9,600
R. A. Friend	Brooklin, Me.	-----	8,000	-----	-----	-----
Tuthill & Co.	South Bristol, Me.	-----	-----	16,583	27,960	27,176
J. G. Nickerson & Co.	Hodgdon's Mills, Me.	-----	-----	43,620	-----	-----
John Hastings	Round Pond, Me.	-----	-----	14,000	-----	-----
Fowler & Foote	South Bristol, Me.	-----	-----	16,000	26,230	17,721
George W. Miles & Co.	do	-----	-----	25,000	37,000	20,000
Job T. Wilson	Blue Hill, Me.	-----	-----	10,400	-----	-----
Pemaquid Oil Company	Pemaquid, Me.	-----	-----	-----	60,000	64,031
Brown's Cove Oil Company	Round Pond, Me.	-----	-----	-----	5,000	-----
Maddocks' Oil Works	Boothbay, Me.	-----	-----	-----	-----	51,610
South Saint George Oil Works	South Saint George, Me.	-----	-----	-----	-----	13,000

Table showing average number of gallons of oil produced by manufacturers of Maine Association.

Name.	Address.	1873.	1874.	1875.	1876.	1877.
L. Brightman & Sons	Round Pond, Me.	135,000	260,000	20,000	146,000	-----
Judson, Tarr & Co.	Pemaquid, Me.	175,000	200,000	-----	-----	-----
Albert Gray & Co.	Round Pond, Me.	70,000	153,665	135,000	120,000	44,000
Jos. Church & Co.	do	250,000	450,000	446,000	600,000	365,761
Gallup, Morgan & Co.	East Boothbay, Me.	55,000	88,264	75,017	111,018	47,880
W. A. Wells & Co.	South Bristol, Me.	62,000	93,000	76,000	87,000	40,000
Gallup & Holmes	East Boothbay, Me.	45,000	71,000	86,000	135,553	121,000
Kenniston, Cobb & Co.	Boothbay, Me.	53,800	84,108	56,656	59,500	-----
Atlantic Oil Company	do	120,000	193,000	140,000	129,000	-----
Round Pond Oil Works	Round Pond, Me.	44,255	87,000	45,000	72,000	8,500
Bristol Oil Works	do	55,000	102,000	70,000	80,000	53,500
Suffolk Oil Works	do	120,000	83,000	-----	82,000	51,000
Loud's Island Oil Works	do	20,000	44,000	30,000	28,000	15,680
R. A. Friend	Brooklin, Me.	-----	22,000	-----	-----	-----
Tuthill & Co.	South Bristol, Me.	-----	-----	48,428	89,000	65,000
J. G. Nickerson & Co.	Hodgdon's Mills, Me.	-----	-----	114,380	-----	-----
John Hastings	Round Pond, Me.	-----	-----	37,000	-----	-----
Fowler & Foote	South Bristol, Me.	-----	-----	36,400	85,000	39,872
George W. Miles & Co.	do	-----	-----	71,000	124,700	45,000
Job T. Wilson	Blue Hill, Me.	-----	-----	28,000	-----	-----
Pemaquid Oil Company	Pemaquid, Me.	-----	-----	-----	180,000	130,000
Brown's Cove Oil Company	Round Pond, Me.	-----	-----	-----	15,000	-----
Maddocks' Oil Works	Boothbay, Me.	-----	-----	-----	-----	118,000
South Saint George Oil Works	South Saint George, Me.	-----	-----	-----	-----	21,000

Table showing average number of steamers employed in fisheries of Maine Association.

Name.	Address.	1873.	1874.	1875.	1876.	1877.
L. Brightman & Sons	Round Pond, Me.	3	4	4	4	-----
Judson, Tarr & Co.	Pemaquid, Me.	4	4	-----	-----	-----
Albert Gray & Co.	Round Pond, Me.	1	2	3	3	4
Jos. Church & Co.	do	4	4	5	7	8
Gallup, Morgan & Co.	East Boothbay, Me.	-----	1	-----	2	2
W. A. Wells & Co.	South Bristol, Me.	1	1	2	2	3
Gallup & Holmes	East Boothbay, Me.	-----	-----	2	3	4
Kenniston, Cobb & Co.	Boothbay, Me.	-----	-----	-----	1	-----
Atlantic Oil Company	do	1	3	6	6	-----
Round Pond Oil Works	Round Pond, Me.	-----	-----	-----	-----	-----
Bristol Oil Works	do	2	2	1	1	3
Suffolk Oil Works	do	1	1	-----	2	2
Loud's Island Oil Works	do	-----	-----	-----	-----	1
R. A. Friend	Brooklin, Me.	-----	-----	-----	-----	-----
Tuthill & Co.	South Bristol, Me.	-----	-----	1	2	3
J. G. Nickerson & Co.	Hodgdon's Mills, Me.	-----	-----	3	-----	-----
Job T. Wilson	Blue Hill, Me.	-----	-----	1	-----	-----
Pemaquid Oil Company	Pemaquid, Me.	-----	-----	1	4	5
Brown's Cove Oil Company	Round Pond, Me.	-----	-----	-----	-----	-----
John Hastings	do	-----	-----	-----	-----	-----
Fowler & Foote	South Bristol, Me.	-----	-----	1	2	2
George W. Miles & Co.	do	-----	-----	2	2	2
Maddocks' Oil Works	Booth Bay, Me.	-----	-----	-----	-----	6
South Saint George Oil Works	South Saint George, Me.	-----	-----	-----	-----	2

Table showing aggregate number of men employed in fisheries of Maine Association.

Name.	Address.	1873.	1874.	1875.	1876.	1877.
L. Brightman & Sons	Round Pond, Me.	80	80	96	60	(*)
Judson, Tarr & Co.	Pemaquid, Me.	60	50	-----	-----	-----
Albert, Gray & Co.	Round Pond, Me.	15	24	40	50	50
Jos. Church & Co.	do	60	70	100	120	140
Gallup, Morgan & Co.	East Boothbay, Me.	27	27	37	† 35	23
W. A. Wells & Co.	South Bristol, Me.	25	20	32	30	40
Gallup & Holmes	East Boothbay, Me.	36	50	† 50	40	60
Kenniston, Cobb & Co.	Boothbay, Me.	40	50	50	50	(*)
Atlantic Oil Company	do	60	60	60	60	-----
Round Pond Oil Works	Round Pond, Me.	30	30	30	40	50
Bristol Oil Works	do	20	20	30	30	40
Suffolk Oil Works	do	60	50	-----	50	23
Loud's Island Oil Works	do	20	20	20	20	42
R. A. Friend	Brooklin, Me.	-----	10	-----	-----	-----
Tuthill & Co.	South Bristol, Me.	-----	-----	20	30	30
J. G. Nickerson & Co.	Hodgdon's Mills, Me.	-----	-----	80	-----	-----
John Hastings	Round Pond, Me.	-----	-----	30	-----	-----
Fowler & Foote	South Bristol, Me.	-----	-----	36	38	42
George W. Miles & Co.	do	-----	-----	50	25	30
Job T. Wilson	Blue Hill, Me.	-----	-----	10	-----	-----
Pemaquid Oil Company	Pemaquid, Me.	-----	-----	-----	50	65
Brown's Cove Oil Company	Round Pond, Me.	-----	-----	30	30	(*)
Maddocks' Oil Works	Boothbay, Me.	-----	-----	-----	30	66
South Saint George Oil Works	South Saint George, Me.	-----	-----	-----	-----	26

* Not operated.

† Hodgdon's Mills, E. B.

Table showing aggregate number of men employed in factories of Maine Association.

Name.	Address.	1873.	1874.	1875.	1876.	1877.
L. Brightman & Sons	Round Pond, Me.	30	40	45	40	(*)
Judson, Tarr & Co.	Pemaquid, Me.	27	30	-----	-----	-----
Albert Gray & Co.	Round Pond, Me.	17	20	30	50	30
Jos. Church & Co.	do	50	70	80	50	60
Gallup, Morgan & Co.	East Boothbay, Me.	9	13	† 17	15	15
W. A. Wells & Co.	South Bristol, Me.	15	16	17	18	12
Gallup & Holmes	East Boothbay, Me.	10	12	† 18	18	20
Kenniston, Cobb & Co.	Boothbay, Me.	11	10	12	17	(*)
Atlantic Oil Company	do	24	20	25	25	-----
Round Pond Oil Works	Round Pond, Me.	15	15	16	15	15
Bristol Oil Works	do	15	16	20	13	15
Suffolk Oil Works	East Boothbay, Me.	16	16	-----	15	18
Loud's Island Oil Works	Round Pond, Me.	10	12	9	12	12
R. A. Friend	Brooklin, Me.	-----	14	-----	-----	-----
Tuthill & Co.	South Bristol, Me.	-----	-----	11	14	13
J. G. Nickerson & Co.	Hodgdon's Mills, Me.	-----	-----	13	-----	-----
John Hastings	Round Pond, Me.	-----	-----	18	-----	-----
Fowler & Foote	South Bristol, Me.	-----	-----	18	14	13
George W. Miles & Co.	do	-----	-----	15	20	15
Job T. Wilson	Blue Hill, Me.	-----	-----	13	-----	-----
Pemaquid Oil Company	Pemaquid, Me.	-----	-----	-----	40	† 30
Brown's Cove Oil Company	Round Pond, Me.	-----	-----	-----	12	(*)
Maddocks' Oil Works	Boothbay, Me.	-----	-----	-----	-----	20
South Saint George Oil Works	South Saint George, Me.	-----	-----	-----	-----	12

* Not operated.

† Hodgdon's Mills.

‡ Bristol, Me.

Table showing statistics of the manufacture of oil and guano in the State of Maine.

	1871.	1872.	1873.	1874.	1875.	1876.	1877.
Number of factories	-----	-----	13	14	17	17	18
Number of sail-vessels	-----	-----	38	37	36	29	13
Number of steamers	-----	-----	17	22	31	43	48
Number of fishermen	-----	-----	533	561	771	758	727
Number of factory hands	-----	-----	249	304	373	371	300
Number of men—total	-----	-----	782	865	1,144	1,129	1,027
Capital in factories	-----	-----	\$278,500	\$316,000	\$397,000	\$434,000	\$459,812
Capital in gear	-----	-----	\$335,000	\$390,500	\$482,000	\$552,000	\$623,800
Capital—total	-----	-----	\$613,500	\$706,500	\$879,000	\$986,000	\$1,083,612
Number of fish (bbls)	-----	-----	429,413	621,661	635,771	709,000	557,145
Number of fish (M)	-----	-----	143,137,616	207,257,600	211,923,666	238,333,660	185,715,000
Gallons of oil	-----	-----	1,204,055	1,931,017	1,514,881	2,143,273	1,166,213
Tons of guano	-----	16,000	12,965	19,295	19,395	21,414	16,666

Returns for the United States.

258. The following table, compiled from data furnished by Mr. Jasper Pryer, shows in detail the statistics of manufacture by some of the principal establishments:

	Number of men employed.		Number of vessels.		Fish caught.		Quantity of products.		Tons guano dried.	Capital.
	In factory work.	In fishing.	Sailing-vessels.	Steamers.	Barrels.	Number.	Gallons oil.	Tons guano.		
MAINE.										
Bristol Oil Works.....	15	40	.....	3	22,700	.....	53,500	600	.....	\$35,000
Albert Gray & Co.....	30	50	1	4	27,300	.....	44,000	800	.....	55,000
Joseph Church & Co.....	60	140	2	8	182,700	.....	365,781	5,400	.....	200,000
Round Pond Oil Company.....	13	30	.....	3	30,413	.....	65,000	900	.....	42,000
Loud's Island Oil Company.....	12	42	2	1	9,600	.....	15,650	975	.....	25,000
Penaquid Oil Company.....	30	65	.....	5	65,539	.....	130,000	1,900	.....	100,000
Wells & Co.....	12	40	.....	3	19,700	.....	40,000	562	.....	60,000
Tutbill, French & Co.....	15	50	.....	1	5,500	.....	8,500	150	.....	21,000
Fowler, Foot & Co.....	13	42	4	3	18,000	.....	39,872	562	.....	42,000
Suffolk Oil Company.....	12	28	3	2	23,400	.....	51,050	710	.....	45,000
Gallup & Holmes.....	20	60	.....	4	51,917	.....	131,000	1,500	.....	70,000
Gallup, Morgan & Co.....	15	23	.....	2	23,910	.....	47,880	700	.....	44,612
Madlocks' Oil Works.....	20	66	.....	6	53,110	.....	118,000	1,600	.....	130,000
Robert A. Frend.....	7	23	2	.....	6,000	.....	1,500	135	.....	5,500
The George W. Miles Company.....	15	30	.....	2	21,000	.....	45,000	73,500	.....	59,000
MASSACHUSETTS.										
Erskeine Pierce.....	10	10	4	.....	15,000	.....	19,000	450	.....	11,000
RHODE ISLAND.										
Job T. Wilson & Co.....	15	40	9	1	53,000	.....	66,250	1,590	.....	40,000
William J. Brightman & Co.....	14	30	6	1	50,000	.....	61,081	1,500	.....	20,000
Isaac Brown & Co.....	15	40	12	.....	13,563	.....	18,350	461	.....	9,000
Charles Cook.....	10	20	3	1	26,000	.....	32,500	700	.....	18,000
Isaac G. White.....	14	20	.....	2	80,000	.....	22,500	540	.....	35,000
James Manchester.....	8	10	3	.....	4,000	.....	5,000	120	.....	3,000
W. H. H. Howland.....	20	30	6	1	.....	13,000,000	43,000	1,100	.....	20,000
CONNECTICUT.										
G. S. Allyn & Co.....	15	45	9	1	.....	13,000,000	41,200	1,200	200	25,000
Leander, Wilcox & Co.....	16	30	9	.....	.....	9,000,000	27,000	1,000	.....	30,000
Waley & Co.....	7	13	4	.....	.....	4,500,000	14,600	200	60	13,000
Quinapiac Fertilizer Company.....	25	40	6	1	.....	13,000,000	43,000	11,100	600	110,000
Luce Brothers.....	30	50	12	1	.....	23,000,000	76,500	900	1,100	50,000
J. H. Bishop.....	8	15	4	.....	.....	5,000,000	18,200	520	.....	9,000

E. R. Kelsey.....	8	10	3	.....	4,500,000	22,000	600	.....	8,000
The George W. Miles Company.....	20	40	12	.....	15,000,000	43,000	1,100	.....	45,000
Fowler & Colburn.....	20	45	12	.....	13,192,400	41,350	1,411	.....	47,000
Westbrook Oil Company.....	6	.....	.....	.....	.....	8,750	210	.....	1,000
NEW YORK.									
Eleven factories in Gardiner's Bay.....	159	298	69	.....	131,500,000	394,500	14,600	.....	310,000
G. H. Clark.....	4	4	2	.....	600,000	1,000	60	.....	500
W. Y. Fithian & Co.....	11	22	6	.....	10,000,000	25,000	12,000	.....	30,000
Smith & Yarrington.....	15	20	4	.....	8,000,000	22,000	800	.....	15,000
Barren Island Manufacturing Company.....	22	40	12	.....	13,150,000	32,854	1,160	.....	17,500
S. Jones & Co.....	22	48	12	.....	14,056,725	36,566	1,545	.....	30,000
NEW JERSEY.									
Griffin & Vail.....	12	11	6	.....	9,000,000	22,500	1,000	.....	10,000
James E. Otis.....	9	11	2	.....	2,500,000	5,000	250	.....	11,000
Cyrus H. Smith.....	8	9	2	.....	3,406,050	7,400	350	.....	7,000
Morris & Fifield.....	6	8	2	.....	1,053,000	2,375	105	.....	5,000

* Fishing off Sandy Hook.

The following table shows the aggregate statistics for the United States for a period of five years:

Table showing statistics of the manufacture of menhaden oil and guano in the United States in the years 1873, 1874, 1875, 1876, and 1877.

[Compiled from the Annual Reports of the United States Menhaden Oil and Guano Association.]

	1873.	1874.	1875.	1876.	1877.
Number of factories in operation.....	62	64	60	64	56
Number of sail-vessels employed.....	383	283	304	320	270
Number of steam-vessels employed.....	20	25	39	46	63
Number of men employed in fisheries.....	1,109	871	-----	-----	-----
Number of men employed in factories.....	1,197	1,567	-----	-----	-----
Total number of men employed.....	2,306	2,438	2,633	2,758	2,631
Amount of capital invested.....	\$2,387,000	\$2,560,000	\$2,650,000	\$2,750,000	\$2,047,612
Number of fish taken.....	397,700,000	492,878,000	563,327,000	512,450,000	587,624,125
Number of fish taken (estimated in barrels).....	1,193,100	1,478,634	1,877,767	*1,535,885	1,958,747
Number of gallons of oil made.....	2,214,800	3,372,837	2,681,487	2,992,000	2,426,589
Number of tons of guano made.....	36,299	50,976	53,625	51,245	55,444
Number of gallons of oil held by manufacturers at the end of the year.....	484,520	648,000	125,000	264,000	94,000
Number of tons of guano held by manufacturers at the end of the year.....	2,700	5,200	1,850	7,275	2,840
Value of oil, at 37 cents.....	\$819,476	\$1,217,950	\$992,140	\$1,107,040	\$897,838
Value of guano, at \$11.....	\$399,199	\$560,736	\$589,875	\$503,695	\$609,884
Total value of manufactured products...	\$1,218,675	\$1,808,686	\$1,582,015	\$1,670,735	\$1,607,722

* The Oil, Paint, and Drug Reporter for January 9, 1877, gives this as 1,708,166.

A comparison of the yield of the whale and other fisheries.

259. In 1875, the total amount of sperm oil from the American whale fisheries was 1,000,951 gallons; of other whale oil, 1,414,186 gallons; in all, 2,505,137 gallons. The amount of menhaden oil for the same year was 2,618,487 gallons, an excess of 176,350 gallons. In 1874, the amount of menhaden oil was 3,372,837 gallons, exceeding that of whale oil by 1,115,597 gallons.

In 1876, 2,990,000 gallons of menhaden oil were made, and in 1877, 2,426,000. For the year ending June 30, 1877, the production of whale oil was 2,140,047 gallons, and for the year 1877, 2,151,765 gallons.

In the "Oil, Paint, and Drug Reporter" for January 14, 1874 (page 4), the following statement is made:

"It is asserted that while the amount of oil produced is equal to that derived from the whale fisheries in this country, the menhaden interest is ahead of the whale, for though the menhaden oil sells at a less price per gallon, for every barrel of oil made there is three-quarters of a ton of scrap, which readily commands \$15 per ton at the factory."

This is not true. In 1874, for instance, the value of the sperm oil alone was \$1,250,987; that of other oils from the whale fishery, \$775,919. Total value of oils from the whales, \$2,026,906; the value of the total products of the whale fishery, \$2,291,896.

By way of further comparison, the cod and seal-oil fishery of Newfoundland and Labrador may be instanced. The latest figures at hand show the product of the seal-oil fishery to be 1,500,000 gallons, and of the cod-oil fishery 900,000.

Comparison of yield of nitrogen from Guano Islands.

260. The refuse products of the oil-factories, together with the fish used in a crude state for manure, are estimated to have yielded in 1875 over 10,000,000 pounds of ammonia in the best possible organic forms. This quantity of ammonia is equivalent to at least 60,000,000 pounds of Chincha Island guano, formerly imported from Peru, the gold value of which would be not far from \$1,920,000.

In addition to ammonia, the phosphate of lime derived from this source and convertible into agricultural products amounted to nearly 1,430,000 pounds, which is the equivalent of nearly 60,000,000 pounds of Peruvian guano.

Associations of oil and guano manufacturers.

261. The Association of the Menhaden Oil and Guano Manufacturers of Maine was formed in the year 1870. The objects were such as are usually sought by organizations of the sort—harmony of action on points affecting the common welfare of the business, social acquaintance, and the communication of information as to improved processes, etc. The annual meeting is held the second Tuesday in January of each year. The United States Menhaden Oil and Guano Association was organized in 1873. The annual reports of these societies are given in full in Appendix L.

46. THE USES OF MENHADEN OIL AND THE OIL MARKET.

The uses of menhaden oil.

262. The uses of menhaden oil are manifold. It is chiefly employed as a substitute for the more costly and popular oils and to adulterate them. It is sold largely to tanneries for currying leather. After the hide has been "dressed," *i. e.*, after its coarser fleshy parts have been pared off, the oil, mixed with tallow, is applied. This is technically called "stuffing," and results in qualifying any residue of alkali left from the "liming" process, and in filling the pores, and softening the leather. Mr. L. C. d'Homergue states that this oil is largely used in the tanneries of Russia.

A considerable quantity is used as a burning oil in coal-mines to fill the small lamps, one of which is fastened to the cap of each miner. It is then mixed with paraffine or some of the heavier oils. Some is also sold to be used in the manufacture of rope. A small quantity is used annually for lubricating purposes, but, on account of its gummy nature, it is not much in favor among machinists.* It is used in adulterating linseed oil, and is also sold as a substitute, its cheapness and durability

* Mr. Isaac Bow, of Springfield, Mass., devoted several years to experimenting, with a view to the preparation of a good lubricating oil from menhaden oil, but his success was not satisfactory.

rendering it especially valuable for rough outside work and for painting ships. Mixed with other oils it is found to be very serviceable for the painting of interiors, and its use is attended with decided economy, its price being about one-half that of the best linseed oil. Some of the most pure is said to be put into the market as olive oil.

Most of that which is exported is used in the manufacture of soap and for smearing sheep after they have been sheared to keep off ticks. Mr. L. C. d'Homergue states in the *Manufacturer and Builder* that a bright fish oil, cut with some alcohol and mixed with paint, forms a far more lasting covering than linseed oil.

The "Oil, Paint, and Drug Reporter" for October 21, 1874, implies that much of the whale oil now sold is really menhaden oil. "It is well known that the chief uses for menhaden oil is for currying leather, but with the low prices ruling of late and the scarcity of whale-oil it has found new channels, and very much of the whale-oil sold probably consists of two-thirds or more of menhaden, for it comes when crude nearly as handsome as any whale, and in appearance when bleached is quite equal. It is reported as a fact about the street that one concern alone sells more 'winter-bleached whale-oil' than is caught of crude, and they do not by any means get all the crude."

The markets.

263. The principal market for menhaden oil is in Boston and New York; some is also sold in New Bedford, and considerable quantities are shipped to London, Liverpool, and Havre direct.

Grades of oil.

264. Several grades are recognized. The "Oil, Paint, and Drug Reporter" usually quotes under the heads of "select light strained," "select light," "choice brown," and "inferior to dark," and "gurry."

The prices of oil.

265. The highest price ever obtained for menhaden oil was \$1.40 a gallon—this was a war price. In Appendix K is given a table showing the current weekly prices of the different grades of oil in the New York market for a period of nearly seven years. This has been compiled from the "Oil, Paint, and Drug Reporter," complete files of which I have been enabled to consult through the courtesy of the editor, Mr. W. O. Allison. This table includes all reliable information regarding the prices current of menhaden oil, and its value is enhanced by the addition of a weekly commentary upon the causes of fluctuation in price and the state of the market, also compiled from the "Oil, Paint, and Drug Reporter." Since the interest in the causes of rise and fall of price is of merely commercial interest, it does not seem to be necessary in this place to discuss the subject in detail. See Appendix K.

Table showing highest and lowest prices of menhaden oil for the years 1871 to 1877.

Years.	Select light.	Choice brown	Inferior to dark.	Gurry.	Strained.	Pressed.	Select light, strained.	Bleached.
1871.....	53 to 55	50 to 52½	47½ to 50	35 to 40	60 to 62½	-----	-----	-----
1872.....	40½ to 41	39½ to 40	35 to 38	20 to 25	58 to 60	-----	-----	-----
1873.....	62½ to 65	60 to 62½	55 to 57½	45 to 50	60 to 65	64 to 66	-----	-----
1874.....	40 to 42½	40 to 41	36 to 38	25 to 30	58 to 65	45 to 50	-----	-----
1875.....	60 to 62	59 to 60	52 to 58	48 to 50	-----	55 to 57½	-----	-----
1876.....	32½ to 35	30 to 32	29 to —	-----	-----	-----	52½ to 55	-----
1877.....	45 to 47½	45 to 46	42½ to 45	-----	-----	-----	40 to 42	-----
1878.....	32½ to 35	35 to 35½	32 to 34	-----	-----	-----	49 to 50	55 to 56
1879.....	45 to 47½	43 to 44	38 to 40	-----	-----	-----	38 to —	44 to 45
1880.....	32 to 33	31 to 32	30 to 30	-----	-----	-----	50 to 52½	55 to 60
1881.....	48 to 50	46 to 48	36 to —	-----	-----	-----	40 to 41	45 to 47
1882.....	32½ to 33	32½ to 33	34 to 36	-----	-----	-----	48 to 50	53 to 54
1883.....	46 to 47	45 to 46	40 to 42	-----	-----	-----	38 to 40	42½ to 45
1884.....	33 to 34	33 to 34	30 to 32	-----	-----	-----	-----	-----

Reviews of the markets.

266. in January, 1874, the manufacturers composing the "United States Menhaden Oil and Guano Association" had on hand 484,520 gallons of oil, or about 21 per cent. of the amount manufactured in 1873; in January, 1875, 643,000 gallons, or about 19 per cent.; in January, 1876, 125,000, or over 4 per cent.; in January, 1877, 264,000, or over 8 per cent.; and in January, 1878, 94,000, or over 4 per cent. These figures seem to indicate that the demand for oil quite keeps pace with the supply.

The following editorial on the value of menhaden oil appeared in the *Oil, Paint and Drug Reporter*, October 21, 1874:

"Prices for menhaden oil have ruled very low this year, and it has probably been relatively the cheapest grease in market. This fact, together with a poor run of fish part of the season, caused several of the weakest of the manufacturers to close their works, and the natural result has been less than an average season's production, except in Maine. The Maine season ended some time since, and the fall catch of the other States, which is usually the best, has thus far been comparatively nothing, and as it will soon close cannot be improved much. To-day we should estimate the stock in the hands of fishermen as fully one quarter less than last year, and with one exception the dealers in this city are almost without stock.

"The entire failure of the Arctic whaling-fleet, the high price of all other grease, and the advance in the price of Newfoundland cod oil point to advanced prices for menhaden. We said early in the season that menhaden oil was cheap at 40 cents, and it ought not to have gone below that price. At the present time some parties talk of 50 cents as the point the market will reach, but we hope that manufacturers will not hold for such high prices; this would be as much too high as 35 cents was too low, and as soon as you get an article above its real value something takes its place and you cannot get it into the same channels until it becomes so low that it is forced back."

N.—MENHADEN AND OTHER FISH AND THEIR PRODUCTS
AS RELATED TO AGRICULTURE.

BY W. O. ATWATER.

Introductory note.

267. Mr. Goode has placed in my hands a number of documents, manuscripts, and letters concerning the use of fish, and particularly menhaden, as fertilizers, with a request for a statement of the more important facts and principles that have to do with the application of these materials to the improvement of agriculture.

The time allowed for this work is, unfortunately, so short as to forbid anything more than a hasty putting together of the data immediately at hand, in the form of a brief review of the history and a still more incomplete outline of the results of scientific investigation and practical experience concerning the preparation, properties, and uses of fish as a fertilizer and as food for stock. I hope that this may serve to explain the chief practical bearings of the subject, to show its importance, and lead to its more thorough investigation hereafter.

The employment of fish products in agriculture offers a singularly forcible illustration of the slowness with which the worth of some of the most valuable materials is recognized, and of the need of scientific investigation and experiment to aid practical skill in utilizing them most profitably.

The loss to the agriculture of our country at large, and particularly our sea-board States, from the waste of fish that might be utilized, the wrong manufacture of the materials that are saved, the export of the best products to Europe, the uneconomical use as fertilizers of what we save and keep at home, and from the almost entire neglect to devote the products to their most profitable purpose, feeding stock and enriching the manure of the farm, if it were capable of accurate estimate, could not fall short of some millions of dollars annually. This is due mainly to the fact that the principles that underlie the right economizing of fish are not generally understood, and, for that matter, are not yet fully learned. It is only lately that science has joined with practice in studying and improving the manufacture and use of fish products for agricultural purposes. The best work in investigation has been done in Europe; its results come to us but tardily. Manufacturers hesitate to apply and farmers are still slower to use them. Everything that brings new knowledge or extends the understanding of what is known must, then, be most valuable.

47. MENHADEN AND OTHER FISH IN A FRESH STATE USED AS A FERTILIZER.

Use among the Indians and early colonists.

268. Professor Trumbull tells us that the Indian names of *Brevoortia*, "menhaden" and "poghaden" (pogy), mean "fertilizer," that which manures, and that the Indians were accustomed to employ this species, with others of the herring tribe (aumsûog and munnawhateâuġ), mostly the alewife (*Pomolobus pseudoharengus*), in enriching their corn-fields. Thomas Morton wrote in 1632, of Virginia: "There is a fish (by some called shadds, by some allizes) that at the spring of the yeare passe up the rivers to spawn in the ponds, & are taken in such multitudes in every river that bath a pond at the end that the inhabitants dounge their grounds with them. You may see in one township a hundred acres together, set with these fish, every acre taking 1,000 of them, & an acre thus dressed will produce and yeald so much corne as 3 acres without fish; & (least any Virginea man would inferre hereupon that the ground of New England is barren, because they use no fish in setting their corne, I desire them to be remembered; the cause is plaine in Virginea) they have it not to sett. But this practice is onely for the Indian maize (which must be set by hands), not for English grain: & this is, therefore, a commodity there."*

This passage is very interesting, showing the use of fish fertilizers in Virginia two hundred and fifty years ago or more, and, from what is known of the habits of the herring family in Virginia rivers and the persistency of local names, there can be little doubt that many menhaden were used among the fertilizing fish, though "shadds and allizes" doubtless includes the shad (*Alosa sapidissima*), the mattowocca (*Pomolobus mediocris*), the alewife (*Pomolobus pseudoharengus*), and the thread-herring (*Dorosoma cepedianum*), all of which are common in spring in the Potomac and other rivers which empty into Chesapeake Bay.

In Governor Bradford's "History of Plimoth Plantation" an account is given of the early agricultural experiences of the Plymouth colonists. In April, 1621, at the close of the first long dreary winter, "they (as many as were able) began to plant their corne, in which service Squanto (an Indian) stood them in great stead, showing them both y^e manner how to set it and after how to dress & tend it. Also he tould them, accepte they got fish & set with it (in these old grounds) it would come to nothing; and he showed them y^t in y^e midle of Aprill, they should have store enough come up y^e brooke by which they begane to build, and taught them how to take it."†

* New England Canaan; or New Canaan, containing an abstract of New England. Composed in three Bookes. * * * * * Written by Thomas, of Clifford's Inn, Gent. Upon ten Yeers knowledge & Experiment of the Country. Printed by Charles Green, 1632. Force's Historical Tracts, Vol. II, .?

† Coll. Mass. Hist. Soc., III, 4th series, 1856, p. 100.

An allusion to the practice of the Indians in this respect may be found in George Mourt's "Relation or Journal of the beginning and Proceedings of the English Plantation settled at Plimoth, in New England, by certain English Adventurers both Merchants and others." * * * "London, 1622": "We set the last spring some twenty acres of Indian corn, and sowed some six acres of barley and peas, and, according to the manner of Indians, we manured our ground with herrings, or rather shads, which we have in great abundance and take with great ease at our doors. Our corn did prove well, and God be praised, we had a good increase of Indian corn, and our barley indifferent good."* * * *

Again, in Edward Johnson's "Wonder-working Providence of Sion's Saviour in New England, Being a Relation of the firste planting in New England in the yeere 1628, London, 1654," written in 1652, the author says: "But the Lord is pleased to provide for them [the colonists] great store of fish in the spring-time, especially alewives, about the bignesse of a herring. Many thousands of these they used to put under their Indian corne, which they plant in Hills five foot asunder; and assuredly when the Lord created this corne, hee had a speciall eye to supply these his peoples wants with it, for ordinarily five or six grains doth produce six hundred."†

Use at the beginning of the present century and later.

269. Menhaden do not appear to have been much used by agriculturists of Cape Cod in the beginning of this century, though the old record shows that the horse-shoe crab and sea-weed were extensively applied.

In 1792 the Hon. Ezra L'Hommedieu, of New York, published a paper in the New York Agricultural Transactions‡ which gives somewhat more accurate data and directions concerning the use of fish as a fertilizer. He says: "Experiments made by using the fish called menhaden or mosbankers as a manure have succeeded beyond all expectation. * * * In dunging corn in the holes, put two in a hill on any kind of soil where corn will grow, and you will have a good crop." He recommends them as a top-dressing for grass. "Put them on a piece of poor loamy land, at the distance of fifteen inches from each other, * * * and by their putrefaction they so enrich the land that you may mow about two tons per acre." But he adds, very wisely, "how long this manure will last has not yet been determined." He gives, in his quaintly interesting way, an account of "an experiment made the last summer by one of my near neighbors, Mr. Tuthill, in raising vegetables with this fish manure," which is worth citing as an illustration of the curious combinations of truth and error, which, in their lack of definite knowledge of the laws of plant-growth and the action of manures, the theorizers of that time invented.

* Coll. Mass. Hist. Soc., 2d series, IX, 1832, p. 60.

† Coll. Mass. Hist. Soc., 2d series, III, 1816, 153.

‡ See Appendix O.

"About the first of June he [Mr. Tuthill] carted near half an ox-cart load of those fish on twenty feet square of poor, light land, being loam mixed with sand. The fish he spread as equally as he could by throwing them out of the cart; being exposed to the weather, they were soon consumed. He then raked off the bones, to prevent their hurting the feet of the children who might go into the garden, and ploughed up the piece and planted it with cucumbers and a few cabbages. The season was extremely dry, and but few cucumbers grew in the neighborhood except what grew on this small piece, and here the production exceeded anything that had before been known. By his own computation and that of his neighbors, this twenty feet square of ground produced more than forty bushels of cucumbers, besides some fine cabbages. I measured the ground myself, and have no doubt of the quantity adjudged to have grown on the same."

Mr. L'Hommedieu's theoretical explanation of this is clear and simple. The fish "enrich the land by their putrefaction." When this process has ceased he questions whether much more good can be expected from them, and doubts if they will make a lasting manure; nor does he find any fault with his neighbor for raking away the bones instead of covering them with earth to prevent their pricking his children's bare feet. In the decomposition a good deal of "effluvia" is evolved, which is evidently absorbed by the leaves of the plants, and contributes to their growth. But "by putting these fish on the land for manure, exposed to the air until they are consumed, there can be no doubt that a considerable part of the manure is lost by the effluvia which passes off the putrefied substance, as is evident from the next experiment." This was made by "Mr. Joseph Glover, a farmer in Suffolk County," who had evidently learned the art of composting fish with earth, and practiced it in a way which some farmers nowadays might improve their ways by imitating.

"He first carts earth and makes a bed of such circumference as will admit of being nine inches thick; he then puts on one load of fish, then covers this load with four loads of common earth, but if he can get rich dirt he covers it with six loads, and in that manner makes of fish and earth a heap of about thirty loads. The whole mass soon becomes impregnated and turns black. By experience he finds that fifteen ox-cart loads of this manure is a sufficient dressing for one acre of his poor land, which produces him thirty bushels of the best wheat by the acre."

Now it happened that Mr. Glover made a heap of fish and earth "in the manner above related near a fence where a field of wheat was growing on the opposite side. The wheat near the heap soon changed its colour, grew luxuriant, and at harvest yielded near double the quantity to the other parts of the field." The improvement in the wheat near the heap, Mr. L'Hommedieu thinks, must be due to the "effluvia arising from the putrefaction of the fish and absorbed by the leaves of the wheat."

President Dwight, of Yale College, visiting Eastern Long Island in 1804, speaks with much approval of the menhaden as a fertilizer, and thus describes the introduction of its use :

“ Their agriculture has, within a few years, been greatly improved. For a considerable period before the date of this journey the land had become generally impoverished by a careless husbandry, in which the soil was only exhausted, and no attempts were made to renew its strength. * * * Within this period the inhabitants, with a laudable spirit of enterprise, have set themselves to collect manure wherever it could be found. Not content with what they could make and find on their own farms and shores, they have sent their vessels up the Hudson and loaded them with the residuum of potash manufactories, gleaned the streets of New York, and have imported various kinds of manure from New Haven, New London, and even from Hartford. In addition to all this, they have swept the Sound, and covered their fields with the immense shoals of white-fish with which, in the beginning of summer, its waters are replenished. No manure is so cheap as this, where the fish abound ; none is so rich, and few are so lasting. Its effects on vegetation are prodigious. Lands which heretofore have scarcely yielded ten bushels of wheat by the acre, are said, when dressed with white-fish, to have yielded forty. The number caught is almost incredible. It is here said, and that by persons of very fair reputation, that 150,000 have been taken at a single draught. Such, upon the whole, have been their numbers, and such the ease with which they have been obtained, that lands in the neighborhood of productive fisheries are declared to have risen, within a few years, to three, four, and, in some cases, to six times their former value.” *

Elsewhere he speaks with equal favor of its use in Connecticut, remarking that it is remarkably favorable to vegetation of every kind, which is the object either of agriculture or horticulture :

“ Within the last twenty years the inhabitants of this [Branford] and other townships along the coast have employed for the purposes of manure the white-fish, a species of herring remarkably fat and so full of bones that it cannot conveniently be eaten. In the months of June and July these fish frequent the Sound in shoals, and are caught with seines in immense multitudes. Ten thousand are considered as a rich dressing for an acre. No manure fertilizes ground in an equal degree ; and none seems more universally favorable to the productions of the climate. Wheat, particularly, grows under its influence in the most prolific manner, and is peculiarly safe from blasting.

* * * * *

“ The following is a strong instance of the fertility of land manured with white-fish : Mr. David Dibble, of Killingworth, from $5\frac{1}{2}$ acres of land dressed with this manure, had in the year 1812, $244\frac{1}{2}$ bushels of rye,

* Dwight's Travels, III, 1822, p. 305. Journey to Long Island, 1804, Letter II.

almost 45 bushels to an acre; the most exuberant crop of this grain which I have known in New England." *

In 1819, Rev. D. D. Field spoke of the use of fish as manure as follows:

"The most efficacious manure in the vicinity of the Sound consists of the white-fish which visit the shores in numerous numbers in June and the first part of July. These began to be used for manure in Middlesex in 1801 and 1802. They are carried as soon as taken and spread upon the land and plowed in; or are thrown into heaps, mixed and covered with earth or turf and suffered to pulverize; and are then spread upon the ground as suits the convenience of the farmers. In either mode the effect even on dry and poor land is wonderful, and though it was at first apprehended by many that after two or three crops they would leave the land poorer than they found it, experience has hitherto proved this apprehension to be groundless.

* * * * * * *

"Eight thousand are requisite to dress an acre. They have been sold lately for a dollar and a half per thousand." †

Dr. DeKay in the *Natural History of New York*, 1842, says:

"The use of this fish as a manure is well known in the counties of Suffolk, Kings and Queens, where it is a source of great wealth to the farmer who lives upon the sea coast. They are used in various ways: For Indian corn, two or three are thrown on a bill; for wheat, they are thrown broadcast on the field and plowed under, although it is not uncommon to put them in layers alternately with common mold, and when decomposed spread it like any other compost. Its effects in renovating old grass fields, when spread over with these fish at the rate of about two thousand to the acre, are very remarkable."

In 1853, Mr. Ker B. Hamilton, governor of Newfoundland, in a "Dispatch to the Duke of Newcastle" on "the Refuse of the Cod Fishery of Newfoundland as convertible into a Portable Manure," says:

"In this island the manure universally applied to the soil is fish, consisting of the superabundant herrings and caplins in the process of decomposition, and generally without any earthy admixture; and the heads, bones, and entrails of codfish, after having been decomposed and formed into a compost with clay or peat-bog earth. This manure * * * when applied to the thin, gravelly, unpromising soil (on the Island of Newfoundland) yields crops of grass and potatoes which, in growth and productiveness cannot be surpassed elsewhere." ‡

Messrs. Boardman and Atkins, in their excellent report on "The Menhaden and Herring Fisheries of Maine," § to which we shall have frequent

* Dwight's Travels, III, 1822, p. 513, 514, 516.

† A | Statistical Account | of the | County of Middlesex, | in | Connecticut. | = | By David D. Field. | = | Published by the Connecticut Academy of Arts and Sciences, | Middletown, Conn. | Printed by Clark & Lyman. | | April, 1819. 8 vo, p. 153.

‡ Jour. Roy. Ag. Soc., 1st ser., XIV, 1853, p. 393.

§ Agriculture of Maine, 1875-6, page 1.

occasion to refer, say: "More than thirty years ago, before fish oil had become a marketable commodity, the farmers of our eastern coast [Maine] were in the habit of using the fish whole in different forms. In some cases, two or three fish were put in a hill for corn, and covered before the corn was planted; in others they were covered by being thrown into the furrow as the land was being plowed, while in instances less frequent they were made into a compost and applied as a top-dressing. These were the ruder forms of using fish as a fertilizer, and generally practiced before the manufacture of oil and the consequent accumulation of fish scrap."

A method similar to the above was formerly in use among the farmers of New Jersey. Prof. George H. Cook, in his report on the geology of that State, says the practice there was to plow a furrow alongside the rows of corn, deposit the fish, and then turn the furrow back again, covering them. In this way the farmers carried their corn through to maturity, and good crops were gathered from the poorest and lightest soils in the State. A Massachusetts correspondent of the "Country Gentleman" (vol. 5, page 152) says the application of fish compost "appears to ameliorate the effects of drouth."

Use at the present day.

270. Mr. Goode states: "even at this day the fish are often applied to the soil in a crude state, though the manufactured fertilizers are superseding it in most localities. Gov. Caleb Lyon tells me that two or three times every summer Staten Island is visited by smacks loaded with menhaden, which are quickly bought up by the farmers. In planting corn, they put two or three fish in each hill, and so with potatoes; when they plant potatoes in rows, a continuous line of menhaden is placed in the bottom of the furrow, head to tail. In 1871, according to Mr. J. M. K. Southwick, many menhaden were sold for manure in Rhode Island at 30 cents a barrel. During the five years previous he had sold about 75 barrels for this purpose."

Until very lately it has been, certainly, and for aught I know is still, the custom of farmers on the Connecticut coast to use whole fish as a top-dressing.

48. FISH SCRAP AS MANURE.

The inception of its use.—Experience in Maine.

271. As a result of the profitable utilization of fish for the manufacture of oil, the use of the whole fish as a fertilizer has gradually and almost entirely ceased, and given place to the refuse from which the oil has been expressed or otherwise extracted. This is known in its crude state as "fish scrap," "fish pomace," or "chum," and when more carefully prepared, as "dry fish," "dry ground fish," and "fish guano." Still farmers have been slow to avail themselves of this more concentrated material. Messrs. Boardman and Atkins, in the report referred to, say:

"Its use in Maine even in this way, notwithstanding the results were almost always satisfactory, except in some instances where it was used in too large quantities, did not seem to extend to any great extent back into the interior; and even along the coast where farmers could get the scrap for the hauling, not half of them made any use of it. When the business of extracting oil from menhaden was first engaged in along the coast of Hancock County, and especially in Union River Bay, the works were situated on shipboard, and the scrap was thrown overboard into the bay. The result of this was to drive out all the deep-water fish, as mackerel, cod, &c., and this was continued for many years. On the first establishment of oil works at Bluehill Falls and other places the scrap was given away, and farmers could get a scow-load any time they wished. It is said that the farmers in the town of Brooklin first utilized the scrap by applying it to the land, and during days when no catch of menhaden would give work at the factories, the men would cart the scrap away and spread it as a top dressing on grass lands. It was used green from the press, and on the sandy soil of that town its good effects were most marked. Afterwards, it began to be composted with muck or with fine loam, and was applied to potatoes and grass with excellent results. As a top dressing to mowing fields it was spread on after haying, and in this way was generally used fresh. Too large an application was found to induce too rapid a growth of grass and to cause it to rust, and it also gave a fishy flavor to the hay, not relished by cattle; but these matters were gradually learned from experience in its use, and as gradually mastered and overcome. As its value became known its price advanced, and for several years, from about 1858 to 1864, it went up to \$6.00 per ton."

Experience in Connecticut.—Mr. Clift.

272. At a meeting of the Connecticut Board of Agriculture in December, 1873, Rev. Wm. Clift, of Mystic Bridge, gave a lecture on "Marine Manures."* This was followed by a discussion, in which a number of the best farmers of the State took part, and is interesting, as showing what the practical experience of men who have used fish scrap as rationally as intelligent farmers do anywhere, says of its uses and value. Mr. Clift said:

"Along the shores [of the Long Island Sound] where I have lived for the last twenty-five or thirty years, very large quantities of white-fish, or menhaden, are taken for the purpose of making oil. Formerly they were taken simply for the purpose of making manures, and were caught in very large quantities all along our shore and over on Long Island, in large seines, which were generally owned by companies composed of farmers. These fish were carted by the farmers quite long distances, spread broadcast over their fields, and left to putrefy in the open air, and then along in the fall they would be plowed in for rye and for other

* Report of Conn. Board of Agriculture, 1873, p. 197.

crops. This, of course, was a very wasteful process, as a large part of the ammonia which the decaying fish furnished went off into the air; still, it was a very valuable manure used even in that way. Not only were white-fish taken, but very large quantities of sharks, and some valuable food-fishes were oftentimes taken in connection with these fish, which were caught expressly for manure. Latterly the oil has become exceedingly valuable, so that the companies now take the fish for the purpose of procuring the oil, and the refuse, what remains after the oil has been expressed, is sold for manure. I suppose about forty millions of white-fish are taken annually along the shore of Fisher's Island, in the sound, between New London and Stonington, a distance of not more than ten miles, probably, and there are some six or eight companies that have been organized for the purpose of taking these fish. These companies are quite prosperous, and a source of quite large income, not only to those who are engaged in fishing, but to other people. They make a market for the wood of the farmers in all that region. It is quite a common thing for the farmers to exchange their wood for this fish scrap. About two cords of wood, delivered on the shore, will buy a ton of this fish scrap. * * * Sometimes they get it in season for the farm [spring?] crops or turnips, and always in season for the rye crop in the fall. The price is from \$13 to \$16 per ton. * * *

A great deal of it goes up the Connecticut River. The tobacco raisers know the value of fish scrap, and it is sent quite a distance into the country. * * *

The farmers all along the coast use the fish scrap in what is called a 'fish pie.' The scrap is drawn to the farm, a few furrows are turned up near where they want to use the fish scrap the next year, a layer of scrap is put over these furrows, then a layer of sods and so on, forming a compost heap four or five feet high. Probably eight or ten times as much earth as scrap is used, in bulk or weight. After it has lain a few weeks in this condition, it is forked or shoveled over, so that it is all intimately mixed, and the scrap very nearly absorbed by the soil, and in that condition it is fit either to be spread upon the ground for rye or for corn crop the next season. It is also used in connection with stable manure. The scrap is carted into the yard where the stable and yard manure is heaped up, and mixed with that; it adds very greatly to the value of yard manure. They will put, perhaps, one ton of the scrap to ten tons or more of yard manure; and then, after it has remained two or three weeks, it is carted off for top-dressing for corn or potatoes, or the ordinary crops of the farm. I have used fish scrap for the last three years on the rye crop, and find it exceedingly beneficial and economical. The soil where I use it is a gravelly loam, very well underdrained, but it has been pretty well exhausted by long cropping. I spread about half a ton of this manure to the acre, and get a very satisfactory yield of rye from this light dressing. It costs me about seven or eight dollars an acre for the manure, and I get in return for it about fifteen bushels of rye to the acre, and

nearly a ton of straw. The straw sells with us for about twenty dollars a ton, and rye is worth from ninety cents to a dollar a bushel; so that for a very small expenditure for manure I get very satisfactory crops of rye. * * * A year ago last summer I used a ton of fish scrap on half an acre of land. It was nothing but gravel. There was hardly any vegetable matter; none but what had grown out of the gravel, and, perhaps, a little washed from the surrounding land. I did not pay anything for the land; the owner did not consider it worth anything. I got a glorious crop of corn, cabbages, and potatoes on that little piece of land, by the use of a ton of fish scrap."

With regard to the value of green and dried scrap and the loss in drying, Mr. Clift says:

"As it comes from the press, after all the oil has been pressed out of it that can be gotten out by the strongest hydraulic pressure, there is still a great deal of moisture in it—40 or 50 per cent. As it lies on the platform under cover, there is, of course, a constant loss of moisture, but there is also a loss of ammonia, which is very valuable, so that I am not able to say whether the fish-scrap is any more valuable after it has lain a month or two in the house than when it first comes from the press. I think I should prefer to take it as it comes from the press. I think the ammonia which is lost is worth more than will be gained by the evaporation of the water. Fish-scrap, at \$12 to \$15 per ton, is the cheapest manure we can buy. It is the only commercial fertilizer I have bought for the last six or eight years. I do not invest in superphosphates or bone-dust. I would invest in the latter if I could get a pure article, but when it is half plaster of Paris I do not know what I am buying. But this article, when it comes from the factory, is generally fish scrap and nothing else. It always produces just about the same result. You can depend upon it. If you apply one or two tons to the acre, you know what you will gain by its use if it is properly put into the soil and you have a fair season. I think it is a perfectly secure investment for the farmer to make."

Experience of Mr. Hall and Mr. Loveland.

273. Some of the discussion which followed is worthy of note. Mr. Hall, of Wallingford, remarked:

"My experience in regard to fish-scrap is that when it comes from the press it is about 65 per cent. water. Now if that is worth \$12 to \$15 a ton to carry back ten or twenty miles into the country, when you come to add the freight and the inconvenience of handling it to the freight, I should consider the dried the cheapest. I have used a great many tons myself, and I have always used the dry as the most economical. I have been so situated I could have either, but I preferred the dry; and as Mr. Clift has said, by analysis, it was a cheap manure at the prices at which it was sold." Mr. Clift replied: "Mr. Hall means a different thing by dried fish guano, from what some gentlemen do by 'dried fish.' He

means the article spread upon a platform, and made as dry as it can be in that way. What is termed 'dried fish' is another thing. It will take from two to two and a half tons of fresh fish to make a ton of dry, and after that has lain in a tight building for some time, it will take two tons of that to make a ton of the dry guano. When the green manure is spread out and immediately dried in the sun, there is no loss of ammonia, but when it is kept in a pile, of course putrefaction begins, and as it advances there is loss of ammonia. There is no considerable loss of ammonia by drying in the sun and of course the dry manure, finely ground, is very much more valuable than that which is dried in a heap where there is a great loss of ammonia."

Mr. Loveland said of his experience with fish-scrap :

"I would say that I have had considerable experience with fish-scrap, having used it for the last eight or ten years. I bought it as it is prepared by the companies at Milford, where it is produced as a superphosphate, and sold at the rate of \$45 a ton. I have used it with Bradley's superphosphate, with Coe's and with Wilson's on tobacco and other crops, and wherever I have used it in connection with these high-priced manures, I have found that the fish manure was fully equal to them; it bore up its crop as well as any of the commercial fertilizers in the market. I have bought it in the green state mostly, in bags and barrels, and it has cost me about \$23 a ton to get it up to the north part of the State. I have not used this fish-scrap much by spreading it upon lands in its raw state, nor by putting it into the hill, as they do in Lyme, and on the coast, in raising potatoes and the like. I have seen some instances in our town where it has been spread upon the ground in a raw state, and then the tobacco set, and the effect has been to stop the growth of the tobacco. It has been too powerful in that condition for the tobacco to grow upon it; and where it has been used in that way, I have never seen half a crop of tobacco. My method has been to compost it, invariably, and I believe that is the true method of using such a fertilizer as that. It is a fertilizer having all the elements of an organized body. It contains all of the fish that we desire; the oil that has been taken out we hold to be of no use in agriculture. Coming to us in the green state from the factory, it has not lost any of its ammonia to speak of, and in that state it must be a perfect manure, because there is no adulteration in it. In composting it, I have used muck, treated with lime and salt—about four cart-loads of muck to four or five hundred pounds of the fish, building up a large pile of it, in that proportion, which, after a while, begins to heat, and the whole mass is leavened and brought into oneness of condition. The fish-scrap fertilizes the whole mass with its elements, and it may then be spread upon natural grass-land or cultivated ground, and will invariably produce a very fine crop. It never has failed with me to produce a good crop, and where I have manured grounds in that way and seeded them down, I have got good crops of grass for years in succession afterwards."

Statements by Professor Cook, of New Jersey.

274. Prof. G. H. Cook, of New Jersey, in his report as secretary of the State Board of Agriculture, writes:*

"The supply of material for fish guano is almost unlimited in this State, and it only needs capital and skill to build up a business of great importance to the State and profit to the manufacturer. On the coasts of Long Island and of Maine, where the business has been carried on for the oil which could be got from the fish, the residuum has been sold at various prices, from \$15 to \$30 a ton, and has been a very popular fertilizer with those who have used it. It is sought for by the manufacturers of superphosphate of lime, to mix with their product, and there can be no doubt that it is very beneficial in such a mixture, giving quickness to its action, while the superphosphate would add to the duration of efficiency. When this source of manure is properly worked, it can be made to supply all the guano needed in the State."

Professor Cook says, also :†

"While the most common mode of using these fish is in the hill or furrow for corn, they are often employed in a compost with barn-yard manure and a little lime. *Those who have tried such a mixture say that it is superior to any guano in the market.* When applied on corn the crop is considered as certain. Some farmers mix them with muck and apply the compost upon wheat. This fertilizer is wonderfully rapid in its effects, showing changes in the growth of a crop in a few days after it has been applied. But it is not a lasting manure. In a year or two this stimulating effect is gone, and a second application is necessary. For producing quick results it is so efficient that all farmers who have tried it unite in testifying to its value."

Further experience in Maine.—Messrs. Hinkley, Kenniston, Smith, and Collins.

275. On pages 47 to 55 of the report of Messrs. Boardman and Atkins, referred to, are some "Practical Notes on the Use of Fish Scrap as a Fertilizer," which contain a number of items of experience of Maine farmers worth quoting:

"Hon. J. T. Hinkley of Bluehill, in a private letter, writes: 'I have never used but it in one way. I mix it with fine dirt or sand, and use it as a top dressing on grass-land. A dressing of one ton of chum mixed with five times that amount of dirt is about the quantity I would put on one-half acre of land, and from that I have a good crop of grass for four to five years without injury to the land. * * * There is an objection here to dressing too heavily with scrap, as it injures the quality of the hay; but using it at the rate of one ton to the acre, in a compost of three parts loam, will produce no effects of this nature.' Now to correct the error

* First Annual Report of the New Jersey State Board of Agriculture, 1874, page 44.

† Geology of New Jersey, 1868, p. 498.

into which a good many farmers are led by statements that the application of fish-scrap, or other active special manures, like guano or superphosphate, damaged the land, rendering it unproductive and sterile; it may be stated here that the real cause of this sterility does not come from the application of these so-called *forcing* manures which are applied to the land, but from the taking off of the large crops which follow their application. They exhaust the soil by drawing from it elements which the manure put on does not contain, and which repeated applications of the same fertilizer would not supply; it is in fact the crop taken off, not the manure put on, which injures the land. But it must also be remembered that after land has been brought up to a condition of productive capacity by the use of fish-scrap or special fertilizers, it can be kept so only by the application of stable and barn-yard manure, or the manure made by consuming the hay grown upon the soil thus improved. This should invariably and in all cases be given back to the land, or the time will speedily come when it will refuse to 'discount.'"

"Mr. William Kenniston, of North Boothbay, furnishes some interesting statements regarding the use of scrap upon his farm. He has used it more or less for the past eight or ten years, and says he 'could not farm without it.' He hauls it from the factory generally late in the fall, as it is dryer then and less objectionable to handle, and composts it with yard and stable manure, muck, and loam. When one year old this is hauled out and spread, in the fall or winter, wherever it is most convenient to do so, at the rate of about eight cart-loads to the acre. In using the scrap without being composted, as he has sometimes done, he regards one ton of well-dried scrap better than three just as it comes from the press. The dry scrap is much easier and better to handle, and may be used on grass at the rate of three tons to the acre; but the raw scrap from the press should invariably be composted. In 1867 he used five tons of scrap mostly in a green state. It killed the corn, the grain lodged and was damaged, and grass has lodged on the piece ever since, although no manure has been applied since. He had spread it on grass fields both in the spring and fall, but preferred the latter. Mr. Kenniston believes if the scrap was packed in barrels just as it came from the press it would stand transportation by steamer or rail to almost any part of the interior of Maine without becoming offensive.

"The farmers in Machias purchase herring chum from Lubec, whence it is brought in small schooners. It is usually packed in barrels of from 220 to 280 pounds each, at \$11.50 per ton, but is not used in very large quantity. Lobster chum, from the canning factories at Englishman's River, is also made use of to some extent as a top-dressing. It is obtained in scows and boats at about \$4.50 per ton, delivered in Machias and vicinity. One ton of it is composted with ten loads of common loam, and this amount spread upon an acre. Applied to grass land in the fall, the results are most satisfactory."

“Mr. H. T. Smith, of Machias, has perhaps made a larger use of fish-scrap, as a fertilizer, in different ways, than any farmer in that place or vicinity. His usual practice is to obtain the scrap (generally herring scrap) in the fall, and apply it in the spring. When grass land is in fair condition he uses about one-fourth of a ton per acre, and never more than one and one-fourth ton per acre. It is, of course, less expensive to apply it directly to the land as it comes from the press, but it is often composted, using three parts of earth to one of scrap. For grain, Mr. Smith has plowed under seven hundred pounds to the acre, from which he has grown very heavy crops of barley, oats, and wheat. Mr. Smith says: ‘I have paid \$80 per ton for superphosphate, and if given my choice had rather have one ton of fish scrap than one ton of superphosphate. If barrelled as soon as it comes from the press (he is speaking of herring scrap, which, it will be remembered, is treated with salt before being pressed), it has no unpleasant odor, and is not offensive to handle. There is nothing equal to it for the land. It is as valuable as night-soil, and is good for grass, grains, corn, garden crops, anything that grows out of the earth.’”

“Capt. Jason Collins, of the steamer ‘Star of the East,’ thus relates, in a private letter, his experience in the use of fish scrap as a fertilizer: ‘My experience in the use of fish chum does not reach over many years, but I have applied it to barley and on grass. The amount used per acre for barley was 1,500 pounds, which was mixed with two parts loam to one of chum. This was spread on and harrowed in. In the fall of 1873, I had five acres plowed up, on which I put 2,000 pounds to the acre. It was harrowed and rolled in the fall, and the following spring, about the last of March, I think, it was sown to grass-seed alone. The grass was cut the last of August, and it was very heavy. I have also used it for turnips and potatoes, and it has done well for each crop. In the fall of 1873 I also had chum spread on some six acres of grass land, as a top dressing, at the rate of three-fourths of a ton per acre, mixed with loam in the same proportions as that used for barley. It did first-rate. This fall (1874) I shall use more, which I shall compost and lay over until another fall, as in that form it will be better about handling. From all I can learn, and from my own experience, I am satisfied that late fall is the best time of the year to apply it as a top-dressing for grass lands; and the amount should be from three-fourths of a ton to a ton per acre. It is best if used as a compost, as I have stated. For hoed crops it must be used very carefully, and should in all cases be thoroughly composted. In regard to its price, it cost me \$12 per ton green, in bulk, and have had it brought from Boothbay to Gardiner in lighters. When in barrels it costs \$15 per ton, but it is cheap at that price, and I shall buy no other fertilizer until I find something better for less money. At \$12 per ton it is cheaper than it is to haul stable-manure, even if the manure is given to you. Perhaps I have not used it long enough to speak of its effects upon the land, but during my experience with it I have witnessed

no ill effects, although if used in too great quantities the grain will grow rank and lodge. I can hardly yet tell what it will do in a long run, but am satisfied with it after a five years' trial."

Other testimony.

276. "Numerous testimonials similar to the above could be given from correspondents and from agricultural reports and journals, but enough has been stated * * to show the great value of fish scrap as a fertilizer when composted or judiciously applied in connection with animal manure. Remark: Too much stress can hardly be put upon this qualification in regard to its use. An instance is mentioned in a former volume of this report* of a farmer who first began to use the scrap; composted it in the fall with three times its quantity of earth. The next spring the mixture had so much the appearance of common earth, and the party had so little faith in its efficacy, that a shovelful to the hill was applied for corn. It came up well, grew for a time looking green and thrifty, but soon began to grow pale, finally died, and the crop was a failure. But the effect of this application was noticeable for many years afterwards, and even with no other application of manures of any kind the land continued to bear an immense burden of grass. In the discussion to which reference has been made, before the Connecticut Board of Agriculture, Mr. Fowler, of Guilford, gave a word of caution which he thought should be exercised in the application of fish scrap. He said: 'My experience has satisfied me it will not answer to use fish alone as a fertilizer for a term of years. It forces the crop and finally leaves the land in very bad condition, very hard and sterile, and it will usually show a pretty heavy crop of sorrel after harvest. But if it is used as it should be invariably, in connection with stable or barn-yard manure, it is perfectly safe to use every year for a term of years for any crop.'"

49. THE MANUFACTURE OF FISH MANURES.

Early attempt at manufacture.

277. The first attempt to manufacture a portable manure from fish is said to have been made by Mr. Lewis, at New Haven, Conn., in 1849.† The white fish, or menhaden (*Brevoortia tyrannus*), was employed, and after a good deal of experimenting a manure produced which contained, according to analyses by Professor Norton, as high as 10.23 per cent. of nitrogen. The enterprise was, however, for some cause, discontinued.

The De Molon process.

278. The next effort in this direction seems to have been in 1851 or 1852, by De Molon, a Frenchman, who, in company with other parties, is

* Hon. S. L. Goodale, Agriculture and Geology of Maine, 1861, page 49.

† See communication by Prof. S. W. Johnson to the Country Gentleman, July 1857, and article on Marine Manures, by S. L. Goodale, Agriculture and Geology of Maine, 1861, pp. 50-56.

said to have put up a manufactory at Concarneau, in the department of Finisterre, for the manufacture of guano from the refuse of the sardine fishery, and one on the coast of Newfoundland, at Quirpon, near the eastern entrance of the Strait of Belle Isle, for the utilization in similar manner of the refuse from the cod fishery. According to the *Chimie Industrielle*, the establishment at Concarneau, in 1854, employed sixteen operatives and worked up daily eighteen or twenty tons of refuse into four or five tons of manure. The composition of this article is noted by Payen at 11.6 per cent. of nitrogen and 10.3 per cent. of phosphoric acid, with only 2.5 per cent. of fat. Other analyses gave about 12 per cent. of nitrogen and 6.7 per cent. of phosphoric acid. The Quirpon establishment was reported as able to produce 8,000 or 10,000 tons of manure annually.

A manufactory of fish guano by the De Molon process was reported as in operation at Lowestoft, in England, in 1856. The same process was said to be employed in 1857-1861, by the Oceanic Oil and Guano Company at Southold, Long Island, N. Y. A pamphlet put out by this company describes the process as follows :

"The raw fish, in quantities of one and two-third tons (or about 5,000 fish), are placed in the inner chamber of a revolving cylinder, the vacuum between the inner and outer chamber being heated by steam at about 80 pounds pressure. Before letting in the steam the cylinder must be put in motion, so that each fish, as the cylinder revolves, is constantly changing its position. The cooking at this pressure of steam requires but ten minutes, during which time a uniform temperature is maintained by means of one head of the inner cylinder being perforated so as to allow the escape of the steam generated from the water contained in the fish, which prevents the dissolution of the gelatine and all the soluble parts, and they are therefore retained in the fish. When the heat in the inner cylinder has arrived at the temperature to produce steam from the fish, it escapes through the perforated head, and thus enables the fish to receive a temperature just sufficient to open the cellular tissues and give an easy and speedy egress to the oil.

"After the fish are thus steamed, they are put into strong bags, prepared in size to fit the top of the press-head, in layers of eight inches of thickness; between each layer or bag is placed a strong iron plate. In this manner the press is filled, when they are subjected for about five minutes to a powerful hydraulic pressure. After the oil has ceased to run, the remains are then put through a strong picker, which reduces the cakes to small particles for the drying process. It is then dried by heated air or by platforms exposed to the sun."

Early manufacture in Rhode Island.

279. Prof. Charles T. Jackson, writing in 1854, remarks :

"In this country a company has been formed, in Rhode Island, for the manufacture of fish manure, and the fat menhaden of Providence River

and Long Island Sound will be used to produce both oil and fish-cake, and the latter, being duly prepared so as to render it inodorous, will be sent into the agricultural market as an artificial guano. I have no doubt of the high fertilizing effects which this guano is capable of producing, nor of the economy of the manufacture proposed.”*

Manufacture in Canada.

280. Mr. Hunt, in the Report of the Geological Survey of Canada, under date of March, 1858, says :

“Mr. Duncan Bruce has lately been endeavoring to introduce the manufacture of fish-manure into Canada; but he conceived the idea of combining the fish offal with a large amount of calcined shale, under the impression that the manure thus prepared will have the effect of driving away insects from the plants to which it is applied.” * * * Analyses of this manure, by Mr. Hunt, showed it to contain about 3 per cent. of ammonia and something more than 3 per cent. of phosphoric acid; and so of less than half the manurial value of a well-made article from pure fish alone.

Manufacture of “cancerine” in New Jersey.

281. Professor Cook, State geologist of New Jersey, in his report for 1856, states that—

“An establishment for making a concentrated manure from king-crabs or horse-feet had been erected at Goshen, in Cape May County, by Messrs. Ingham & Beesley. Several hundred tons of this substance were made last year and sold under the name of *cancerine*. It is a powerful fertilizer, and in its composition, as well as in its effects, has considerable resemblance to guano.” The average per cent. of ammonia and phosphoric acid in “cancerine,” as shown by three analyses by Professor Cook, was 9.92 per cent. of ammonia and 4.05 per cent. of phosphoric acid, and he estimates its value at \$31 per ton; and further says, “the results of trials with it have fully sustained its value as determined by analyses.”

Early manufacture in Maine.

282. Mr. Goodale says further, in the report referred to :

“Until within a few months, I was not aware that any attempt had been made in our State to manufacture a portable manure from fish; but I have recently learned of several. In Boston I found an article for sale under the name of ‘fish-guano,’ which by inquiry was ascertained to have been made by a Mr. Fowler, at Lubec. I learned subsequently that he had manufactured a quantity two or three years previously, but that either from not finding a ready sale, or from other causes, had discontinued its manufacture. It is understood to have

* Report of the Commissioner of Patents for the year 1854—Agriculture.—Washington * * * 1855, p. 107.

been made by drying the fish after pressure, when it was ground and a portion of gypsum mixed with it. As offered for sale, it was a grayish powder, in which portions of bone could be distinguished.

"Learning that a somewhat similar article had been sold and used in some of the Penobscot towns, from Mr. C. G. Alden, of Camden, I called upon him, and found that he had made last year, for the first time, about a hundred barrels, at Long Island, in Blue Hill Bay, which he sold readily at \$1.50 per barrel of about 150 pounds, and learned that it gave entire satisfaction. It was prepared from poggy chum by simply drying it in the sun, and when packed he added a peck of gypsum to each barrel. Some barrels were examined which had just been made (August, 1861), and the article appeared to be in a good state of preservation, except that it was slightly moist and gave off free ammonia. Mr. Alden intimated that the lack of sufficient capital alone prevented his entering into its manufacture upon a much more extended scale. He hoped, however, to prepare five hundred barrels or more the present season.

"At Eastport I found fish guano manufactured upon a larger scale. Messrs. U. S. Treat & Son, well known for their enterprise, perseverance, and success in the artificial propagation of fish, after preliminary trials for some years past, prepared about one hundred and fifty tons during the season of 1860, nearly the whole of which was shipped to Connecticut. He makes it under a patent held or claimed by the Quinunipiac Company of Connecticut. It is manufactured almost entirely from herrings, of which they formerly cured a large amount, but now find it more profitable to make it into guano. They are caught in weirs (about Treat's Island, on which they reside), and are thence taken to a railway running into the water and dipped into a car, drawn up by a windlass. When the car comes to be opposite one of a tier of tanks near the track, a gate or door in the car is opened and the fish slide in; salt is added in the proportion of one bushel to each hogshead (of four barrels) of fish. After pickling for about twenty-four hours, they are moderately heated in open kettles, when they are pressed to obtain the oil, of which they yield about 8 per cent., and to express as much of the water as possible; after which the cake or chum is broken up, spread on a platform of boards, and dried in the sun. It is subsequently ground and packed in bags of two bushels each, and which contain eighty pounds—twenty-five bags or about fifty bushels to the ton of two thousand pounds. He sells it for \$15 per ton; and the cost of the bags, delivering or shipping, are extra charges.

"The platform in use last year for drying is about eighty by one hundred and twenty feet square, slightly inclined to the sun, with a storehouse on the lower side. Another was in process of erection when I was there, as also another railway and other conveniences for extending their operations.

"The patent held or claimed by the Quinnipiac Company is understood to be 'for drying by solar heat upon an elevated platform.' If a patent be granted for this, why not for drying salted fish upon an elevated flake, or for drying clothes on an elevated line, by solar heat? From various sources, I learn that the fish guano prepared by this method gives high satisfaction.*

"Prof. S. W. Johnson, of Yale College, chemist to the Connecticut State Agricultural Society, informs me that the article prepared by the Quinnipiac Company is the most popular fertilizer sold in that State.

"To sum up in a word the results of my investigations and experiments regarding the manufacture of a portable, inoffensive, and efficient manure from fish or fish offal, I may say that I deem the same practicable; that no costly machinery or complicated processes are required; that all which is necessary is, first, to cook the fish sufficiently to coagulate the albumen contained in it; then to express as much of the oil and water as may be, and to dry the remainder as quickly and thoroughly as possible. A pickling of the fish first with salt would probably facilitate the operation.

"It is confidently hoped that the waste of such enormous quantities of fertilizing material as have hitherto been thrown will not much longer go on, but that they may be converted to use, feed our hungry fields, and fill our barns with plenty."

Early manufacture in France.

283. Turning again to the manufacture of fish manures in Europe, we note that the process of De Molon, referred to above, is described by Deherain (*Wurz Diet.*, ch. I, 1236) as follows: "The fish are first boiled, then pressed to force out the water and oil; the residue is then dried and ground in a mill." De Molon's first factory was at Concarneau, Department of Finisterre. He seems to have established others on the English coast and in Newfoundland, in company with Thurneysen. From disconnected statements in different works to which I have had access, the industry on the French coast seems to have suffered from lack of material. A company, "Credit Mobilier," into whose hands the enterprise fell, attempted to use city refuse with it, but through business complications, stock speculations, etc., the whole undertaking failed.

About the same time that De Molon introduced his method of manufacture in France, Pettit and Green patented another process in England (1852), the peculiar feature of which was "the use of sulphuric acid, which was added to change its consistence." After treatment with the acid, the fish was dried in hot air.

*According to Mr. Boardman, Mr. C. G. Allen, of Camden, Me., was engaged in 1862 in making fish guano from "pogy chum," by drying it in the sun. (Rept. U. S. Dept. Ag., 1862, p. 57.)

Early manufacture in England.

284. From an article in the "Farmers' Magazine" (London) for August, 1859, by Samuel Osler, of Great Yarmouth, who claims to have discovered a method preferable to that of De Molon or Pettit, a few paragraphs are quoted by Mr. Goodale:

"The enormous consumption of guano, its high price, and extensive adulteration, have led to a desire of an auxiliary or substitute. The most obvious source is the fishery. * * * What we require is a simple, cheap, and effectual mode of separating the parts which are needless for manure—the water, gelatine, and oil, the two latter sufficiently pure to be commercially valuable, and leaving the fiber, bones, and scales in a state fit for keeping and for use. It has been ascertained by experiment, and confirmed by actual working, that the refuse and waste fish may be thus converted, and the gelatine and oil collected by a process which I have discovered. The machinery and the process are simple, inexpensive, and effectual. The principle of the manufacture is founded upon the fact that when fish or flesh is subjected to a long-continued and moderate heat the fluids separate, dissolve the gelatine, and leave the fibrous and bony solids. This is easily shown by putting meat or fish into a flask and setting it in boiling water, corking the flask when fully heated. The fluids will gradually separate, while the flesh will, after a time, be left a dry and insipid residuum."

Mr. Osler gives the results of several analyses by Professors Way and Voelcker and Dr. Stoeckhardt, by an average of which it appears to contain about 12 per cent. ammonia and 7 per cent. of phosphates.

Other European manufacture.

285. In the Paris International Exhibition of 1855, among the specimens of artificial manure was one, "*engrais poisson*," prepared from fish, which, "after being steamed, were pressed into cakes and dried." It was "said to contain from 10 to 12 per cent. of nitrogen, and from 16 to 22 per cent. of phosphate (= $7\frac{1}{2}$ to 10 per cent. phosphoric acid). The price was about \$35 per ton.

On the coast of the North Sea, at Varel, in Oldenburg, immense numbers of a kind of small crab (*Crangon vulgaris*), called in German *Granaten*, or *Granülen*, are taken, dried, ground without any steaming, and thus made into what is called "Granat guano."

On the coast of the Baltic Sea, at Labagiehnien, near Labiau, in East Prussia, considerable fish refuse has been manufactured into a fertilizer.

The following are analyses of the articles just named:

	Nitrogen, per cent.	Phosphoric acid, per ct.
Fish guano, Pettit.....	9.1	7.6
Fish guano, Green, No. I	9.1	1.6
Fish guano, Green, No. II	13.8	0.2
Fish guano, De Molon and Thurneysen	11.6	10.1
Granat guano	11.2	2.2

These figures are taken from a report by Professor Schmidt, of Dorpat, on the "Artificial fertilizers at the second Baltic agricultural exhibition, June, 1871," who adds that none of the articles seem to have attained enough importance to secure a place in the wholesale market.

The Norwegian fish guano.

286. By far the most important of European fish-waste products, in fact the only one that has been made in large enough quantities to bring it into very general and widespread use, is the Norwegian fish guano, manufactured from the waste of the fisheries on the Lofoden Islands, and elsewhere on the Norwegian coast.

In the Polar Sea, near the 70th parallel, north latitude, off the extremely wild, rough, and dangerous coast of Northern Norway, near the famous and dreaded maelstrom, lies a group of islands, rough, rocky, and precipitous, the peaks of some shrouded in eternal snow, about 40 in number, and bearing the name Lofoden. The neighboring mainland is inhabited by nomadic tribes of Laplanders. The islands have neither four-footed beasts nor food for them to live upon; but the sea about them teems with fish, and the air with sea-fowl. But few human beings are there, except during the fishing season, from February until April, when from 12,000 to 14,000 fishermen come, with 3,000 to 4,000 boats; bring scanty supplies of coarse bread, dried fish, and bacon; live in miserable huts, sleep in sheep-skins; and with lines that have sometimes as many as 3,000 hooks apiece, catch from 18,000,000 to 20,000,000 codfish per annum. These fish are cut up; the sides are dried and sold as "stock-fish" all over the world. A part of the residue is used in the northern regions as cattle food. The heads and backs were formerly thrown into the sea or left to rot upon the rocks. Of late years, however, they are gathered, dried upon the rocks by the sun's heat, ground in factories that are scattered about in sheltered bays, and thus made into the Norwegian fish guano. A business circular concerning the Lofoden fishery products says that the cods' heads and backbones are collected mostly by women, children, and infirm persons, who cannot take part in the fishing, dried either on the bare rocks or on poles, and then ground, put in bags of about 2½ cwt., and shipped; the material delivered at Hamburg at the rate of about £9 per (long) ton. The circular adds that "it has been a great benefit to the Lofoden fisheries to get rid of this waste which formerly spoiled the bottoms of the fish banks, and infected the harbors, where in some places it used to lie knee-deep upon the beach." Another account states that the gathering of the refuse has already become an important industry for the poor people there.

The earliest notice I have seen of the Norwegian fish guano is by Stoeckhardt* in 1855, who then reported the manufacture as started on

* *Der Chemische Ackermann*, I, 1855, s. 236. See articles by Stoeckhardt and by Meinert in same journal, I, 1856, s. 118; V, 1859, 44; VI, 1860, 59; IX, 1863, 117; XV, 1869, 43; XVI, 1870, 43 and 53; XVI, 1871, 245; and *Landw. Centralblatt*, 1874, 613; and by Vohl. *Dingler's Polyt. Jour.*, CCXV, 1875, 460.

the Lofoden Island by Dr. Scheibler and Herr Fröhlich. In 1856, Stoeckhardt informs us that a joint stock-company had been formed at Christiania for the manufacture of the guano, and had taken the patent from Dr. K. Hansen and F. C. Schübler. (The Dr. Schiebler above?) The company consisted of these two gentlemen and three others, Messrs. Fröhlich, Broch, and Heftye. In 1859, he reports the manufacture as having finally begun in the past season (1858) on a large scale. In 1860, the guano was offered for sale in Germany, by Mr. Meinert, of Leipsic. In 1863, Mr. Meinert states that, "unfortunately," the fish guano has become so popular in Norway, Sweden, and Denmark, that a large part of the supply has been retained there, and not enough will reach Germany to supply the demand. In 1869, Meinert reports to the "Ackersmann" that the manufacture has attained such a degree of perfection that an article can be offered of uniform composition, and containing 8 to 10 per cent. of nitrogen and 10 to 15 per cent. of phosphoric acid.

In 1870, it was stated that the refuse of 4 to 5 million codfish was worked up into guano, while that of the remaining 14 to 15 million was still allowed to go to waste.

In 1871, Meinert, whose accounts of his journeys to Lofoden, published in the "Chemische Ackersmann," are well worth the reading, reports the success of attempts, undertaken by himself, to make guano from whole fish, from kinds whose inferior value for human food had caused them to be sold at very low prices or to be used in Norway for cattle food. From these "waste fish" 200 tons of guano had been prepared, of so good quality that a content of 11 to 12 per cent. nitrogen and 5 to 6 per cent. phosphoric acid. The high proportion of nitrogen is due to the use of the whole fish. It finds rapid sales at higher prices than the ordinary guano.

In 1874, the "Landwirthschaftliches Centralblatt" (XXII, 613) speaks of the Norwegian guano as follows:

"The Norwegian guano, as is well known, is made of the heads and backs of the cod.* These fish are taken from January to May, all along the coast from Finmark to Hammerfest, lat. 68-71 N., but especially on the Lofoden Islands. During the season 2,000 fishermen are engaged. The catch of cod has averaged during the past ten years, according to statistical reports, from 18,000,000 to 22,000,000. The sides of the fish are dried either on lines upheld by posts or upon the rocks. Those prepared in the former way are sold in Spain, Italy, &c., under the name stock-fish; the others are sent to Russia and Sweden, under the name of *Klippfisch*.† The refuse was formerly thrown into the sea or left to the sea fowls, except the small quantity used as fodder

* The *Dorsch*, *Gadus callarias*, common Cod, and *Kabeljau*, *Gadus molva vel morrhua*, Ling, are both said to be taken at Lofoden. Sometimes one and sometimes the other is named as the principal fish of those fisheries. [They are the same. G. B. G.]

† *Stock*, rod, stick; *Klippe*, rock; so cod. Anglo Saxon *gād* or *goad*, a rod, and the Latin *gaudus* has a corresponding Sanscrit root, *cad* or *gad*, a rod. See paper by J. C. Brevoort, on the names of codfish.

for cattle and sheep. The heads (some as large as small calves' heads) and the backs of the cod (*Dorsch*) form the chief raw material for the fish guano. They are dried in the air on the rocks, then torn up by machines, and finally ground to a product resembling coarse bone meal. Since, however, not inconsiderable quantities of cod are also caught along the Norwegian coast southward from Lofoden, as far as Aalesund, the preparation of fish guano has offered the inhabitants a new and useful industry; the demand has increased every year and since the supply has not sufficed even for the German market, a considerable number of larger or smaller factories have sprung up all along the west coast of Norway. Competition soon led to the manufacture of a more finely ground product, and to the utilization of a large portion of the available material for preparation of fish guano. Nevertheless, a good deal of the material was still allowed to go to waste, so that the production of the guano is capable of further development. Recognizing this fact, Dr. A. Meinert, son and business partner of the original German importer, has, in connection with some German merchants, established two new factories in Norway, one in Lofoden, the other in Hammerfest. The former was completed during the past summer (1874). The guano from these establishments is first steamed, then dried and ground to a fine dust, and is consequently very similar in its action to Peruvian guano."

The report adds that, on account of the difficulty of transporting fish guano to Sweden, factories have been put up in that country also, to supply the home demand.

The most remarkable enterprise in this direction is one for the manufacture of guano from whale refuse, on the boundary between Norway and Russia, beyond the North Cape, in the latitude of 70°. It was undertaken in 1870-1873, by Capt. Svend Foyn, who is described as "the greatest whale fisherman of our time." With his fleet of steam and sailing vessels he visits the coast of Greenland in February to catch seal, and thence sails in March to the North Polar sea in pursuit of whales. He captured, in 1869, thirty-two whales and expected to be able, by use of improved vessels and appliances, to take fifty per annum. A whale, according to Captain Foyn, weighs on an average 230,000 pounds (115 tons); each fish furnishes about 80,000 pounds of fat, several hundred pounds of whalebone, and 100,000 pounds raw stock for fish guano. Fifty whales are expected to produce 2,500 tons of the latter, containing 8 per cent. of nitrogen and 12 per cent. of phosphoric acid. The enterprise seems to have halted somewhat from the great difficulties to be overcome, but at last accounts still promised success.

The distance from markets and industrial centers, the wildness of the coast, the inclemencies of the weather, and the length of the arctic winter night, have all combined to make the successful manufacture of

the Norwegian products a very difficult matter. The bulk of the products have, I understand, been sold in Germany by Mr. Meinert, who has from the first had control of the trade in that country. Mr. Meinert has managed the business in such a straightforward and rational manner as to secure not only a large personal profit but also the confidence of the agricultural public. This he has done by personally aiding and encouraging the manufacture of an article of high grade and uniform quality, by selling it on the basis of guaranteed analysis, and thus recommending to the good sense of the most enlightened farmers.

According to Déharain (*Wurz Dict. Ch. I, 1236*), a Frenchman, M. Robart, has established a manufactory of fish guano at Lofoden. This is probably the one referred to by Herr Meinert as "an incomplete imitation" of the previous manufactories there, and in aid of which the French Government gave a subvention of 100,000 francs. That so large a gift should be made to aid this enterprise is proof of the importance ascribed to it by the French Government.

According to the "Revue Scientifique," August 25, 1875, M. Levy has lately started an establishment at the French island of St. Pierre, in the Gulf of St. Lawrence, for the purpose of utilizing the gurry and offal of the codfish, &c., taken on the banks of Newfoundland. All the heads, entrails, &c., are gathered in, and after the extraction of the oil the residue is made into gelatine and fertilizers.

How important such an industry may be made appears from the fact that the waste material of the fisheries of that region is estimated at 120,000,000 pounds per annum.

Manufacture of glue and removal of oil in preparation of Norwegian fish guano.

287. It is worthy of note, that in the European factories the liquid coming from the steamed or boiled fish, and containing considerable nitrogenous matter in solution, is utilized for the manufacture of a low quality of glue, while in this country the practice is to throw it away.

The Norwegian guanos have generally smaller percentages of fat than occur in the menhaden guanos in this country. But even this small amount is objected to by many, on the ground that it retards the fertilizing action. According to Vohl, this objection has been removed by Radde, of Hamburg, by the manufacture of so-called fatless, evaporated, polar fish guano, in which a minimum of 8 per cent. of non-volatile nitrogen and of 12 per cent. of phosphoric acid is guaranteed, and actual analysis of a sample gave a considerable excess above this minimum. This article is in the form of a fine dry powder, of a yellowish color, with a comparatively feeble odor. It absorbs water rapidly, and when moist putrefies readily at 52°, with copious formation of ammonia. It yields on ignition 37 to 38 per cent. of ash.

Success of fish guano as a fertilizer in Europe.

288. A few words upon the use of fish guano in Europe may be in place here.

In 1855 Professor Stoeckhardt, of Tharand, wrote* of fish-refuse as a manure:

"Fish forms the basis of all natural guanos, since it forms the sole food of the sea-birds (and seals, &c.), from whose excrement guano is formed. * * * What is accomplished naturally here by the digestive processes of the bird, pulverization, fine division and concentration, must be done artificially by the ingenuity of the chemist. If the chemical and mechanical operations necessary for working over the crude material rapidly, on a large scale, into a product of good quality and at low price, can be devised, then it is for the interest of agriculture to be put as quickly as possible in possession of this product, whose office it may be to break the monopoly held by guano."

After describing at length the manufacture, composition, and fertilizing effects of materials prepared from fish, he warmly recommends them to the farmers of Germany as the "guano of the future."

At this time the fish guano was just coming into the European market; but little was known from experience or experiment as to its actual value for farming. In 1869, after it had stood the tests of repeated chemical analyses, gone through the trial of manifold field experiments, and run the gauntlet of practical farmers' experience, with ever-increasing popularity and favor, Stoeckhardt wrote again:

"Fish guano has entirely fulfilled the prophecy which I made for it fourteen years ago, at its first entrance into the commercial world, * * * and it is to be desired in the interest of agriculture that its manufacture may assume ever-increasing dimensions." * * *

The manufacture of fish fertilizers in the United States.

289. We may now return to the manufacture of fish fertilizers in the United States.

At present nearly all the material in our market is made from the menhaden, which after the extraction of the oil leaves a residue which is prepared in various forms for fertilizers.

The attempt of Mr. Lewis in East Haven, Conn., in 1848, to make a concentrated fertilizer from menhaden has been referred to. The first practical success in this direction was attained by Mr. W. D. Hall in 1853. "He discovered how the oil might be extracted from the fresh fish in a few hours' treatment, leaving the 'pomace' or 'scrap' in such a condition of half-dryness that it could be stored or barreled and transported at once, or could be further dried by exposure to the sun and converted by grinding into 'fish guano.'" The history of the manufacture of oil from menhaden since that time is given very fully in Mr. Goode's report on the menhaden.

* *Der Chemische Ackersmann*, 1855, I. 236.

Fish refuse and kinds of fertilizers made therefrom.

290. It is of interest for us to consider here the "scrap" or pomace left from the manufacture of the oil, and its uses.

The fish-refuse enters our markets in several different conditions. The following have come under my observation :

1. "*Crude stock*," "*green scrap*," "*chum*," or *crude pomace*.
2. "*Half dry scrap*" or *half dry pomace*.
3. "*Dry scrap*" or *dried fish*.
4. "*Dry ground fish-scrap*," *dry ground fish* or "*fish guano*."
5. *Fish guano from which the most of the fat has been extracted by special processes.*
6. *Acidulated fish.*
7. "*Fish and potash salts*."
8. *Fish mixed with superphosphates in the form of "ammoniated" superphosphates, sometimes called guanos.*

No. 1 is the raw material as it comes from the press.

No. 2 is the form it assumes after partial drying. More or less fermentation is apt to take place during the drying. This is often accompanied by considerable loss of nitrogen in the form of ammonia. Large quantities of this "half dry scrap," "half dry pomace," or "fish pomace," as it is variously called, are used by farmers along the coast where menhaden are taken.

No. 3 is the coarse scrap dried by the sun's heat or artificially. This also is used in large quantities by farmers near the coast.

No. 4 is prepared by grinding the dried scrap. It makes a reasonably fine, dry, quick acting, and excellent fertilizer.

The green scrap or crude guano generally contains 55 to 60 per cent. of water. The half-dry scrap contains 40 to 50 per cent. of water. The dry guano contains 10 to 20 per cent. of water.

The following measurements and estimates are said to be in use among menhaden manufacturers :

1 ton (2,000 pounds) is reckoned the weight of 3,000 fish.

2½ tons of fish yield 1 ton (40 per cent.) of green scrap, chum, or crude pomace.

3 tons of fish yield 1 ton (33 per cent.) of half dry scrap.

5 tons of fish yield 1 ton (20 per cent.) of dry scrap or guano.

One thousand menhaden, weighed by Mr. Dudley, president of the Quinipiac Fertilizer Company, at Pine Island, June 12, 1877, weighed 685 pounds. Mr. Dudley has kindly furnished the following statements:

"We take them from the fishermen at so much per thousand, reckoning 22 cubic inches per fish. One thousand fish, measuring 22,000 cubic inches, weighs 667 pounds (3,000 to the ton).

"6,000 to 7,000 fish make 1 ton of 'green scrap' from the press. The last I weighed took 6,700 for a ton. Green scrap contains 55 to 65 per cent. of moisture.

"10,000 fish, on the average, yield 1 ton of half dry scrap, containing 40 to 50 per cent. of water.

"15,000 fish, on the average, make 1 ton of sun-dried scrap, containing 10 to 20 per cent. of moisture."

"In regard to prices for the past ten years, we have sold fish scrap or half dry fish, as it is called in Connecticut Valley, in car-load lots in bags, free on board cars at New London or New Haven, as follows:

"1869, \$20 to \$24 per ton; 1870, \$23 to \$25 per ton; 1871, \$20 to \$25 per ton; 1872, \$16 to \$19 per ton; 1873, \$18 to \$20 per ton; 1874, \$19 to \$23 per ton; 1875, \$15 to \$17.50 per ton; 1876, \$17 to \$20 per ton; 1877, \$14 to \$17 per ton; 1878, \$17 to \$18 per ton.

"Prices in bulk at factory are usually about \$3 per ton lower than at New Haven, owing to cost of packages, labor, and freights. Dry ground fish guano was retailed ten years ago at \$55 per ton, now at \$40 to \$42.50; wholesale, \$5 per ton less."

Methods of manufacture and need of improvement.—Statements by Prof. C. A. Goessman.

291. The following statements from the Third Annual Report of the Massachusetts State Inspector of Fertilizers, Prof. Goessman, who has given a great deal of attention to the subject of fish manures, are of special value in this connection. Professor Goessman gives an analysis of a sample of dried fish scrap obtained at the chemical works under the charge of Hon. S. L. Goodale, at Booth Bay, Me., where large quantities of fresh scraps were delivered direct from the press of an adjoining fish-rendering establishment. It was deemed a particularly fair sample of a well-rendered and carefully-dried menhaden fish. It contained 10 per cent. of water, 70.75 per cent. organic matter, 18.25 per cent. ash, 8.46 per cent. phosphoric acid, and 8.14 per cent. nitrogen.

"About one third of the entire phosphoric acid proved to be soluble in citrate of ammonia. Ether abstracted at ordinary temperature 18 per cent. more of a thick, highly-colored, oily mass.

"The following rules of rendering the fish were stated as being customary in the establishment above mentioned: the fish were boiled for about one-half to three-quarters of an hour, by means of steam of from 70 to 80 pounds' pressure, in large wooden tanks with false bottoms; and subsequently, after the soup had been withdrawn, subjected to a pressure of about 115 to 120 pounds per square inch. The fish mass, in consequence of its gelatinous condition, retains usually still from 50 to 55 per cent. of moisture. In a large fish-rendering establishment near New York City, I noticed that the boiling of the fish was continued only 25 minutes, with steam of 50 pounds' pressure, and the rendered fish mass subsequently treated with 160 pounds' pressure per square inch.

"The soup, which contains besides the oil more or less of the glue-producing, soluble nitrogenous matter of the flesh and the bones, is at present discharged after, by means of settling-tanks, the oil has been care-

fully removed. This practice causes a considerable waste of nitrogen. The yield of oil differs, often widely, even during the same season, being, it was stated, usually highest during autumn. The rendering begins usually in May or June, and closes late in the fall. The quality of the fish refuse in general, independent of its moisture and mechanical condition, depends, quite naturally, to a large extent, on the following circumstances :

“First. On the kind used and whether entire or in part.

“Second. On the peculiar mode of rendering.

“Third. On the time when the fish are caught.

“Fourth. The course pursued in keeping and preparing the refuse for the general market.

“Each of these circumstances exerts an influence of its own on the composition of the fish guano.

“Judging from general appearances, but little attention is paid thus far to the first three conditions ; the influence of the last one is, more or less, fully understood, yet not satisfactorily controlled. A main difficulty, no doubt, arises from the irregular arrival of large quantities of fish at one time during the season ; and the means, which are at present usually employed to meet this difficulty, are, quite frequently, inadequate to the demand. Many manufacturers of fish-oil consider it, therefore, apparently a safer proceeding to dispose at once of their crude stock at low rates than to run the risk any longer. Without questioning the soundness of their course of action, in case of limited pecuniary means, there seems to be no valid reason why improvements should cease here as long as it is daily demonstrated that it pays well to collect animal refuse matters from all over the country and to work them into valuable concentrated fertilizers.

“Nobody familiar with the nature of a good fish guano considers it less efficient for agricultural purposes than any other animal refuse matter of a corresponding percentage of phosphoric acid and nitrogen. In fact, all true guanos, the Peruvian not excepted, owe their most valuable constituents, in a controlling degree, directly or indirectly to the fish.

“Our fish guano consists of the entire body of the menhaden fish, which has been deprived purposely of its main portion of fat, and, incidentally, more or less completely of its soluble nitrogenous matter. The more the flesh predominates, the more the fat has been abstracted without the application of an excessive heat, as far as time and degree are concerned, the higher will be the commercial value of the residue of the press in case of an equal percentage of moisture. The flesh of the fish, like that of our domesticated animals, contains on an average 15 per cent. of nitrogen. The same close approximate relation exists between the bones and the textures of these otherwise widely differing classes of animals ; for the fish-bones and the scales consist, mainly, of a varying quantity of cartilaginous (nitrogenous) matter and of (tricalcic phosphate) bone phosphate.

"To produce a fish guano which contains in a given quantity the largest possible amount of nitrogen, must be the principal aim of the manufacturer. It brings the highest pecuniary compensation; for one percentage of nitrogen is commercially equal to 4 per cent. of phosphoric acid.

"During the past, it is true, there has been little inducement for considerations of this kind on the part of the manufacturer, because practically there has been scarcely any serious discrimination on the part of the consumers regarding the exact relative chemical composition of the various fish guanos offered for sale.

"The future prospect of this branch of home industry depends, in an unusual degree, on the exertions which hereafter shall be made, on the part of the manufacturers, to meet the present more exacting conditions of the trade in fertilizers.

"To derive any full benefit from the capital invested renders it advisable, for all parties pecuniarily interested in the fish guano manufacture, to favor a closer scientific investigation into the changes which the menhaden fish undergoes during the customary mode of rendering.

"Loss of nitrogenous matter, in consequence of misapplication of heat, seems to be not always compensated for by an increase of the yield in oil.

"The latter, when left in the fish mass in an undue proportion, reduces, to say the least, the commercial value of the guano by adding a worthless matter, which may affect seriously the analytical results, as far as its percentage of nitrogen is concerned. To heat the fish to a higher temperature, or for a longer period of time than is required to secure the largest possible amount of oil, reduces, invariably, the commercial value of the fish mass for agricultural purposes. A few subsequent analytical statements, regarding the composition of fish, and the degree of the changes which they may suffer by steaming and rendering, may serve as a practical illustration of my previous remarks.

"A well-dried and finely-ground fish guano is one of our best substitutes for Peruvian guano, and ranks equally high with the best quality of animal dust from our butcher refuse establishments. It deserves the liberal patronage of farmers wherever a rich nitrogenous phosphate is called for.

"I have shown in a previous report, that, as a general rule, the high grades of superphosphates are cheaper than our low grades; the same rule applies to nitrogenous materials.

"The recent changes in our fertilizer trade tend to stimulate improvements in the modes of their manufacture, by rendering true merits prominent, which, as a natural consequence, secures a reliable patronage only to the best quality. We are not yet suffering from an overstocking of our fertilizer markets on account of overproduction of home-made fertilizers obtained from suitable home resources.

"Millions of dollars are annually sent abroad still, for the importa-

tion of materials, which, in their crude form, are by no means better than what we have in abundance at home.

"The manufacture of fertilizers has become in the same degree an art, as agriculture itself has justly assumed the claim of being a science.

"The production of fish guano, although respectable already, as far as quantity is concerned, is thus far but incidental to the menhaden fish-rendering industry.

"It remains still an open question whether our resources for the manufacture of fish guano do not extend beyond that branch of industry."

Statements of Mr. Maddocks.—Manufacture in Maine.

292. From the fifth report of the secretary of the association of the menhaden oil and guano manufacturers of Maine, Mr. L. Maddocks, which is devoted to "The Menhaden Fishery of Maine," the following quotations are taken. The manufacturing processes are those prevalent on the Maine coast, particularly in the region of Booth Bay :

"The fish [as brought in by the fishing vessels] are discharged into a car running upon a rail-track to the second story of the factory, and thence poured into tanks below, holding sixty to seventy-five barrels. These are filled one-third with water, steam turned on, and the fish cooked an hour, or until the albumen is coagulated, and the oil-cells broken. The cooked mass, after draining, passes into presses worked by hydraulic power, and is subjected to the pressure of a hundred tons per square inch, the oil and water flowing out and being collected in vats. The oil is then drawn off, clarified by settling, barreled, and is ready for market. The residue, called chum or scrap, is usually stored in the lower story of the factory until taken away by the purchasers, chiefly the manufacturers of ammoniated superphosphate of lime.

"The following figures will give more definiteness to the statement :

"One hundred and ninety-five pounds of fish make a 'barrel.'

"One barrel yields about two and a half gallons of oil, or eighteen and three-quarter pounds."

"One barrel yields about eighty pounds of fresh chum or scrap.

"These are average results of the manufacture as now conducted in this State. The amount of oil realized varies from one gallon per barrel of fish, early in the season, to four or five gallons in September."

"The scrap contains, on the average as it comes from the press, 55 to 60 per cent. of its weight in water, and sometimes more. This is of course worthless for fertilizing purposes. It also contains from 12 to 20 per per cent. of fat or oil, which is equally worthless for manure.

"As now generally managed, the scrap remains in large heaps until shipped, in autumn or winter, to the points of manufacture into superphosphate. In this time a portion of the oil and water leaks away, so as to leave about 10 or 15 per cent. of the former, and 48 to 53 per cent. of the latter. The elimination of the water is an advantage, but the

specified per cent. of oil is lost, and a portion of nitrogen is also lost, resulting from the partial decomposition of the mass, the formation and escape of ammonia. It were better, if practicable, to drive off the water at once upon withdrawal from the press, so as to prevent the loss in question."

Goodale's new process.

293. I have spoken of fish guanos from which the most of the fat has been extracted by special processes (Class No. 5, of page 600). One of these is Mr. Goodale's, of which Mr. Maddocks speaks as follows:

"What has hitherto prevented the driving off of the water immediately by artificial heat has been the presence of so much oil, together with the gelatinous or gluey matter which is developed during the cooking, chiefly from the skins and bones. These render the process of drying the scrap a very difficult and tedious one, so much so that comparatively little has been put into the market in that desirable form. The recent discovery of an easy and simple process for removing the larger part of the oil, and also at the same time the gelatinous hinderance to drying, gives promise of a speedy change in this respect. While pursuing investigations relative to utilizing the menhaden as a source of concentrated food, before referred to, Mr. S. L. Goodale, formerly secretary of the board of agriculture, discovered that it was chiefly by the agency of the gelatine that the remaining oil was held in the scrap. He found by thoroughly washing new scrap with sufficient hot water, and agitation, that it lost its jellyish consistence and slimy feel, and that the oil globules were liberated from their lock-up in the tissues, so that the greater part could be easily recovered by draining and repressing, and also that after such washing it could be pressed much drier than before.

"We can now readily understand why it is that oil, together with a purid, watery liquid, leaks away from new scrap not many days after it is removed from the press. It is simply because dissolved gelatine, being more readily putrescible than other animal substances, quickly decomposes, and changes to a thin, offensive liquid, which partly drains off. This decomposition, or the change of consistence attending it, so 'lets the bars down,' that more or less oil escapes, while subjected to no pressure whatever, except its own weight.

"Thus by a very easy process, the oil product may be largely increased, the scrap left free from the gluey hinderance to drying, and with less water to be dried out.

"It may appear strange that so simple a method should not have been discovered sooner, but such is the fact. Work had been done on both sides of it. Re-pressing had been tried, using extra strong curbs, with very powerful pressure, but it failed to give satisfactory results. Re-cooking had been resorted to, which resulted in injury to the oil and in the development of an additional amount of the gelatinous matter. It is now seen that a simple thorough washing in hot water accomplishes the desired end, with neither of these objectionable results.

"Scrap made by this process last August (1877), and dried in the open air, was lately analyzed at the agricultural experiment station of Connecticut, and the statement of the director, Prof. S. W. Johnson, of New Haven, shows the proportion of moisture to be reduced to 11.45 per cent., or about one-fifth that contained in the scrap fresh from the press; and the proportion of oil to 4.65 per cent., thus proving that the content of oil in the *washed scrap as it came from the press* (before drying it) had been reduced to less than $2\frac{1}{2}$ per cent. [The percentage of nitrogen was 10.24 per cent., the phosphoric acid 7.50 per cent. These figures refer to the material as dried in the open air.]

"According to these figures, the proportion of oil hitherto lost is, by the new process, reduced from an average of, say 15 per cent. of the weight of the scrap as it commonly issues from the press, to about 2 per cent. The balance, say 12 or 13 per cent., is saved. Let it be assumed, however, that only 10 per cent. can be realized in practice, and that the annual out-turn of scrap from the factories of the Maine association be only 40,000,000 pounds. This would give an annual saving of 4,000,000 pounds of oil, or 533,000 gallons, worth, at current prices at market for 1877, forty cents per gallon, \$213,200.

"With reference to drying by artificial means, which is obviously important, no doubt is felt that the apparatus now in operation will effect the work as thoroughly as may be desired, and cheaply and quickly also, provided only the oil and gelatine in the scrap be reduced as above described.

"Two companies belonging to the association have succeeded in drying the scrap in considerable quantities, notwithstanding the obstacles referred to. The scrap is passed through a slightly inclined heated iron cylinder thirty feet long and four feet in diameter, and on the passage is agitated by paddles attached to a revolving shaft, and comes out at the lower end dried to about 25 per cent. of moisture. The process will be greatly promoted in dispatch and efficiency by the application of the new oil-saving method, and the whole manufacture will then be under full control. The scrap can at once, upon withdrawal from the press, be subjected to the drying process by furnace heat, irrespective of the state of the weather, and thus the loss of ammonia by decomposition be forestalled. If the contained moisture is reduced to a per cent. no lower even than 20 or 25, the scrap can be kept on the spot at convenience, and without offense to the senses, or transported as required."

Adamson's process.

294. The other process for extracting fat from fish is that of Adamson. It depends upon the use of hot petroleum, naphtha, or benzine, to dissolve the oil. Whole fish, menhaden, or others, as well as scrap, are said to be arranged in layers, in an inclined iron cylinder, the naphtha or benzine directed upon and passed through them. In the passage the oil is extracted from the fish, which are left in an excellent form for dry-

ing and grinding. The process is said to be easy, simple, and effectual. The main drawback is the necessity for new apparatus and the rejection of a good share of the appliances now used.

Two samples of fish guano prepared in this way and analyzed at the Connecticut experiment station gave, respectively :

	Per cent.	Per cent.
Moisture.....	4.91	3.67
Oil	2.07	....
Nitrogen.....	10.78	10.74

Immense waste of fish at present.—Possibilities of future manufacture.

295. The accounts of these new processes at my disposal are meager. They seem, however, to promise well, and, if successful, must revolutionize the manufacture of fish guano. The great desideratum has been a means of removing the oil as entirely as possible, saving the nitrogenous matters and yielding a fine, dry product. This seems to have been found. I understand that the Adamson process is to be used in the manufacture of a fertilizer from the fish that are taken along the coast, but thrown into the sea again on account of their low value for oil or food. The benefit to our agriculture from such an economizing of fish hitherto wasted would be immense. Concerning the number of fish thus lost Mr. Goode writes: "I estimate that the amount of fish annually thrown away from the hundred and fifty-odd weirs on our coast cannot fall much short of ten millions of pounds annually, and probably far exceeds that."

"Acidulated fish" and "fish and potash salts."

296. The "acidulated fish" (class No. 6 on page 219) is prepared by treating the fish scrap with sulphuric acid to render the phosphoric acid more soluble. Unfortunately the constitution of the tissues of the fish is such as to resist the action of the acid, and the desired result is only partly attained. A sample examined under the writer's direction gave 7.09 per cent. of phosphoric acid, of which only 1.76 per cent. was soluble in water.

It will be remembered that Pettitt's process for the manufacture of fish waste into a fertilizer was based upon treatment of the fish with acid, and did not prove a success.

Various efforts in this same direction are reported in this country and in Europe, but none, as I can learn, have been found profitable. The imperviousness of the tissues to the action of the acid has thus far been an insurmountable obstacle to success, and will probably remain so.

The "fish and potash salts" (class No. 7, above) is a mixture, as its name represents, of fish, half-dry scrap apparently, in the specimens I have seen, with German potash salts. The idea is a sound one, in that the salts used, doubtless of the lower grades, like Leopoldshall Kainit, and containing large percentages of chloride of sodium (common salt),

would act as a preservative, and further, the potash supplies a lack in the fish and makes of it a "complete" fertilizer.

The amounts of the "acidulated" fish and "fish and potash salts" in the market are so small as to give them very little importance.

Manufacture of "ammoniated superphosphates."

297. The most important use of fish waste is in the manufacture of nitrogenous, "ammoniated," superphosphates. These fertilizers, which constitute by far the largest class in the market, owe their value mainly to the two ingredients, nitrogen and phosphoric acid. For phosphoric acid various fossil and mineral phosphates, particularly those from South Carolina and the Island of Navassa, are employed. Of late, mines of apatite have been opened in Canada, and promise to be a rich and important source of phosphates for this purpose. The waste boneblack from sugar refineries is also used in very large quantities for the same purpose. Bone meal is likewise employed, but to a limited extent. The phosphoric acid in all of these is in insoluble or very slowly soluble forms. To render it more available, the phosphates are treated with sulphuric acid, and thus superphosphates are produced.

Various materials are used to supply nitrogen (ammonia) to superphosphates. Dried blood and meat-scrap from slaughter-houses are, next to fish, the most important materials in common use for this purpose. Formerly a good deal Peruvian guano was employed. In Europe considerable sulphate of ammonia is used, but manufacturers there are learning that they can get nitrogen cheaper in American fish and slaughter-house products, and thousands of tons of our best nitrogenous materials are annually taken from us and sent across the Atlantic to enrich English, French, and German soils.

According to the report of Mr. Maddocks, already referred to, "nineteenths of the fish scrap turned out at the works of the Maine association are bought by the manufacturers of superphosphate to ammoniate their products, of which 400,000 tons are produced yearly in the United States. They combine it, when dried and pulverized, with South Carolina phosphatic rock, ground bones, with imported guano deficient in ammonia, &c. It is understood that not over one ton of the fish guano is used in connection with three or four tons of the mineral ingredients."

The largest manufacturers of superphosphates in this country are the Pacific Guano Company, whose works are at Wood's Holl, Mass., and near Charleston, S. C. This company use fish and the Charleston phosphate for the manufacture of their superphosphate, the "Soluble Pacific Guano." The Quinnipiac Fertilizer Company, of New Haven, Conn., whose works are on Pine Island, near New London, Conn., and the Cumberland Bone Company, of Boothbay, Maine, are, with the Pacific Guano Company, the best representatives of this most useful industry. The detailed descriptions of their factories and methods of manufacture, prepared by Mr. Goode, are at once too extensive to be

conveniently inserted here, and of too much interest to be condensed, and are therefore given in the Appendix O.

50. CHEMICAL COMPOSITION OF MENHADEN AND OF FISH MANURES.

Analysis of whole menhaden and of flesh and bones of whale.

298. The only analysis of whole menhaden I have noticed is given by Prof. G. H. Cook.* The specimens were taken in the Raritan River the latter part of October.

"Five of the fish weighed four and one-fourth pounds—their average weight being three quarters of a pound. The oil was first separated by adding water to the fish and boiling until the flesh was reduced to a pulp. The oil was then skimmed off and purified from water and other substances by ether. It then weighed 2.66 ounces, which is equivalent to 3.914 per cent. of the original weight of the fish. The substance of the fish remaining was then strained out and carefully dried in an air bath, at a temperature of 290° F., when the dry mass was found to weigh 11.8 ounces. On account of the solvent power of the sulphuric acid, which was added to the fish, it was thought proper to separate all the mineral matters from the fluid in which the fish had been boiled, add them to the dried fish, excluding of course the sulphuric acid. These weighed 1.1 ounces, and added to the weight of dried fish given above, 11.8 ounces, made for the whole weight of the dried matter 12.9 ounces, which is equivalent to 18.93 per cent. of the original weight of the fish. There was still left in the fluid some animal matter, which could not be satisfactorily separated, and was left out. The water in the fish was 77.15 per cent. as ascertained by deducting the percentage of oil and dried matter from 100. The nitrogen in the dried fish was ascertained by ultimate analysis to be 7.76 per cent., which is equivalent to 9.28 per cent. of ammonia. The mineral substances contained in the fish were freed from the organic matter by pressing, and then separated from each other by the ordinary process of analysis."

Analysis of the fresh fish.

Water	77.150
Oil	3.914
Dried fish	18.936

Analysis of the dried fish.

Lime.....	8.67
Phosphoric acid.....	7.78
Silicic acid	1.33
Potash.....	1.54
Soda.....	1.02
Magnesia.....	0.67
Chlorine	0.69
Organic matter and loss	78.30
	<hr/>
	100.00

* Geology of New Jersey, 1868, p. 497.

The following analysis by Stöckhardt* of the flesh and bones of the whale may not be without interest in this connection :

I.—*Flesh of the whale.*

	Raw, per cent.	Perfectly dry (including fat), per cent.	Without fat and entirely dry, per cent.
Water.....	44.50	.....	.....
Fat.....	22.81	40.70	.....
Flesh.....	32.10	57.44	96.80
Mineral constituents (ash).....	1.64	1.86	3.20
Nitrogen.....	4.66	8.68	14.60

II.—*Steamed bones of the whale.*

Water.....	3.84	per cent.	
Cartilaginous mass (glue).....	34.60	"	=(3.5 per cent. nitrogen.)
Fat.....	1.34	"	
Bone phosphate of lime..	51.66	"	=(23.66 per cent. phosphoric acid.)
Carbonate of lime.....	8.56	"	

Analysis of fish fertilizers.

299. The following tables illustrate the composition of some of our more common fish fertilizers. Those in Table A are from analyses reported by the writer.† Those in Table B are reported by Prof. S. W. Johnson:‡

TABLE A.

Kind of fertilizer.	Station number.	Moisture.	Organic matter.	Ash.	Phosphoric acid.	Nitrogen.	Ammonia equivalent to nitrogen.	Oil.
<i>Dry ground fish:</i>		<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
Ground fish, G. W. Miles.....	10	18.74	61.82	19.44	7.65	8.66	9.78	6.71
Fish guano, G. W. Miles.....	28	21.96	50.99	27.05	8.66	6.07	7.36	.....
Charles Island guano, G. W. Miles..	80	8.63	71.79	19.41	7.74	8.84	10.73	.....
Allyn's fertilizer.....	24	.....	.....	16.37	6.17	8.20	10.68	6.35
Allyn's fertilizer.....	185	6.34	71.31	22.35	7.90	7.88	9.56	7.33
Dry ground fish, Quin nipiac Fertilizer Company.....	100	14.64	.....	22.23	6.67	7.50	9.11	7.68
Dry ground fish, Quin nipiac Fertilizer Company.....	140	10.85	68.40	20.75	7.21	7.38	8.97	.....
Dry ground fish, Quin nipiac Fertilizer Company.....	172	13.45	63.97	22.58	7.55	7.96	9.66	6.63
Dry ground fish, Quin nipiac Fertilizer Company.....	203	8.22	.....	20.41	8.11	8.25	10.00	8.94
Acidulated fish, Quin nipiac Fertilizer Company.....	222	36.53	39.89	23.58	*7.09	4.11	4.99	.....
<i>Crude fish scrap:</i>								
"Dry fish," Green Brothers.....	179	11.04	64.01	24.95	10.51	8.60	10.44	3.93
"Dried fish".....	182	9.37	.....	19.92	7.10	8.13	9.86	.....
"Dry fish".....	189	11.00	.....	20.17	7.12	7.46	9.05	8.29
"Fish scrap".....	190	7.74	.....	.....	.....	7.10	8.61	.....
"Dry fish".....	196	7.59	.....	.....	.....	7.79	9.46	.....
"Dry fish".....	199	.....	.....	.....	.....	7.65	9.28	.....
<i>Half-dry fish scrap:</i>								
Fish scrap, "half dry".....	103	40.95	43.06	15.99	6.23	5.33	6.47	.....
Fish scrap, "half dry".....	131	25.10	56.17	18.73	7.49	5.49	6.66	11.99
<i>Crude fish pomace:</i>								
"Fish scrap".....	197	56.83	.....	.....	.....	3.63	4.41	.....

* Per cent. soluble in water, 1.76; per cent. soluble in ammonium citrate, 2.47.

* Chemische Ackersmannu XVI, 1870, 52.

† Report of Connecticut Agricultural Experiment Station, 1876, p. 63.

‡ Report of Connecticut Agricultural Experiment Station, 1877, p. 41.

TABLE B.

Kind of fertilizer.	Station number.	Moisture.	Nitrogen.	Nitrogen in water-free fish.	Oil.
		<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
Dry ground fish-scrap	9	10.75	8.52	9.54	
Dry ground fish-scrap	12		8.21		
Dry ground fish-scrap, old, 1876	15	16.59	7.35	8.81	
Dry ground fish-scrap, new, 1877	16	23.95	7.30	9.59	
Dry ground fish-scrap	17		9.26		
Dry ground fish-scrap	18		8.77		
Dry ground fish-scrap	22	19.57	7.98	9.02	
Dry ground fish-scrap	43	9.03	8.04	8.83	
Dry ground fish-scrap	45	11.38	8.51	9.60	
Dry ground fish-scrap	46	10.74	8.43	9.44	
Dry ground fish-scrap	50	9.76	7.77	8.61	8.94
Dry ground fish-scrap	52	11.19	8.78	9.28	7.30
Average		13.66	8.24	9.36	8.12
Fish by Adamson's process	36	4.91	10.78	11.32	2.07
Fish by Adamson's process	39	3.67	10.74	11.15	
Fish by Goodale's process	41	11.45	10.24	11.56	4.64

Waste from faulty manufacture and use of fish fertilizers.

300. An enormous loss results to our agriculture from the waste of fish that might be saved, from faulty manufacture of fish into fertilizers, from wrong use of the fertilizers when made, and from the exportation of the best products to Europe, where their value is better understood. This loss will be prevented in proportion as the nature and uses of fish manures are learned.

51. THE USE OF FISH FERTILIZERS IN AGRICULTURE.

Chemistry of plant nutrition.

301. Not only farmers and merchants, but many manufacturers as well, have a very poor understanding of what constitutes the value of fish as fertilizers, and how they may be most economically utilized. It will be well, therefore, to consider briefly some of the principles that decide the value and usefulness of fertilizers in general, and of fish products in particular.

Fish manures, like other commercial fertilizers, are valuable because they supply plant-food which crops need and soils fail to furnish. Their main value depends upon their content of nitrogen and phosphoric acid. These are the most valuable and costly ingredients of commercial fertilizers.

Plants, like animals, require food for life and growth. A part of the food of plants is supplied from the atmosphere, the remainder is derived from the soil. No ordinary cultivated plant can thrive without a sufficient supply of each of a number of substances needed for its food. With an abundance of all of these in forms in which the plant can use them, and with other circumstances favorable, the plant will flourish and the yield be large. But if the available supply of any one of them

be too small, a light yield is inevitable. For instance, *potash* is an *essential ingredient* of the food of plants. If all the other conditions for a profitable crop of corn or potatoes, or other plants, are fulfilled in the soil, except that potash is deficient, the crop will inevitably fail. But if the potash be supplied the yield will be abundant. The chief use of fertilizers is to supply the plant-food which the soil lacks.

Vegetable and animal substances, and manures and soils as well, contain, besides *water*, two kinds of materials, the so-called *organic matter* and the *mineral matter* or *ash*.

The *organic matter* consists chiefly of the four chemical elements, *carbon*, *oxygen*, *hydrogen*, and *nitrogen*. We do not need to trouble ourselves about the first three of these in fertilizers, because they are supplied to the plant in abundance by the atmosphere and the soil through the leaves and through the roots.

But the nitrogen is an important ingredient of fertilizers. It is, in its pure state, a gas, and makes up about four-fifths of the air. Combined with hydrogen it forms ammonia; combined with oxygen it is known as nitric acid. In these and other combinations it occurs in minute quantities in the atmosphere, and in considerable quantities in soils and manures. Plants are unable to make use of the pure nitrogen of the air, though some, if not all, absorb a very little combined nitrogen from the atmosphere. By far the largest part of the nitrogen of plants is absorbed from the soil through the roots. From the facts that nitrogen is available to plants only in certain combinations, that it is slow to form and easily leaves these compounds, that it readily escapes from manures and soils into the air, and is leached away by water, it is one of the most commonly deficient and hence the most costly ingredients of the food of plants.

The mineral matter or ash of plants is derived entirely from the soil. It consists of several ingredients, known as potash, soda, lime, magnesia, iron, silica, sulphuric acid, phosphoric acid, and chlorine.

Essential ingredients of plant-food.

302. The results of a vast amount of this sort of experimenting prove that no agricultural plant can attain full growth without a sufficient supply, through its roots, from the soil, of *potash*, *lime*, *magnesia*, *iron*, *phosphoric acid*, *sulphuric acid*, and some compound of *nitrogen*. Besides these, chlorine, and perhaps silica, are sometimes, if not always, indispensable, though in very small proportions, to complete development. If any one of these *essential ingredients* be lacking the plant will suffer in growth and development.

Exhaustion of soil by various crops.

303. Crops take from the soil, then, the materials needful for their growth; and these are rightly called "plant-food." Some soils yield large crops many years in succession without manuring. They do this

because they contain large stores of the ingredients of plant-food, as potash, lime, nitrogen, &c., and because these are furnished in available forms, so that the plant can readily use them. As a rule, after cropping for some time, the point is reached where the natural resupply of plant-food is insufficient to produce large crops. In other words, in the so-called "poor," "worn-out," or "exhausted" soils, the natural strength is insufficient for profitable production.

In order to know what fertilizers to use on such soils we must know what ingredients of plant-food are deficient, and what manures will best supply them. An idea of the essential ingredients of plant-food removed from the soil in cropping may be obtained from the table below, which is calculated from the extensive tables of analyses of plants by Wolff.

Materials removed from the soil by various crops.

Crops.	Sulphuric acid.	Phosphoric acid.	Lime.	Magnesia.	Potash.	Nitrogen.
	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
RYE.						
Grain, 25 bushels=1,400 pounds	0.3	11.8	0.7	2.9	7.8	24.6
Straw, 3,500 pounds	3.8	7.3	12.2	3.9	27.3	14.0
Total	4.1	19.1	12.9	6.8	35.1	38.6
OATS.						
Grain, 30 bushels=960 pounds	0.4	6.0	1.0	1.8	4.2	18.4
Straw, 2,000 pounds	2.6	3.8	7.2	3.2	17.8	11.2
Total	3.0	9.8	8.2	5.0	22.0	29.6
WHEAT.						
Grain, 20 bushels=1,200 pounds	0.1	9.5	0.7	2.4	6.4	25.0
Straw, 3,000 pounds	3.3	6.6	8.1	3.3	18.9	14.4
Total	3.4	16.1	8.8	5.7	25.3	39.4
CORN.						
Grain, 50 bushels=2,800 pounds	0.6	16.5	0.8	5.6	10.4	44.8
Stalks, 6,500 pounds	7.8	34.5	26.0	16.9	62.4	31.2
Total	8.4	51.0	26.8	22.5	72.8	76.0
HAY.						
Mixed grasses, 1½ tons=3,000 pounds	7.2	12.3	25.8	9.9	39.6	46.5
POTATOES.						
Tubers, 150 bushels=9,000 pounds	5.4	1.44	1.8	3.6	51.3	30.6
TOBACCO.						
Leaves, 1,800 pounds (1,260 pounds dry)	14	7.5	73	17	71	49
Stalks, 1,100 pounds, dry	3	15	15	2	47	33
Total	17	22.5	88	19	118	82

Large quantities of silica, and small quantities of soda, chlorine, and iron, are also removed from the soil by every crop. Iron is necessary to the growth of all agricultural plants, but in very minute quantity. In many cases small amounts of chlorine seem to be requisite. Silica, if needed at all, which is quite doubtful, is required only in extremely

minute proportions. Soda does not appear to be an essential ingredient of plant food. In so far as these latter are *essential* ingredients of plant food, they are furnished in abundance by every ordinary soil.

Ingredients most commonly lacking in worn-out soils, and hence most important in fertilizers; nitrogen, phosphoric acid, and potash.

304. For our present purposes, then, we have to consider only the potash, lime, magnesia, sulphuric acid, and nitrogen. Of this list the magnesia is commonly, though not always, supplied in sufficient quantities in even "worn-out" soils. Sometimes its presence in fertilizers may be of considerable importance to crops. Sulphuric acid and lime are more often deficient, and hence one reason of the good effect so often observed from the application of lime and plaster.

The remaining substances, the nitrogen, phosphoric acid, and potash, are the most important ingredients of our common commercial fertilizers, because of both their scarcity in the soil and their high cost. It is in supplying these that fish guano, phosphates, and bone manures are chiefly useful.

In brief, then, in order that crops may grow, they must have at their disposal an adequate supply, in available forms, of each one of a certain list of essential ingredients of their food. Soils differ in respect to their supplies of these food ingredients. The crop cannot rise above the level of the lowest ingredient in the food supply. The chief use of fertilizers is to fill up the gaps.

Principles to be observed in the manufacture and purchase of fertilizers.

305. The cardinal principle to be observed by the farmer in the purchase of fertilizers is, to—

Select those which furnish, in the best form and at the lowest cost, the ingredients of plant-food that his crops need and his soil fails to supply.

The principle that should guide the manufacturer should be, to—

Economize all available materials in his manufacture so as to furnish the valuable ingredients in the best forms in products of high grade and uniform composition, and at the fairest practicable rates.

The most important ingredients of our fertilizers, because the most rare and costly, are nitrogen, phosphoric acid, and potash. The two first are the most important. These are supplied in large proportions in fish.

Composition, character, costs, and uses of fertilizers in general.

306. It will be to our purpose, then, to note briefly :

1. The composition of some of our more important commercial fertilizing materials, particularly those which, like fish manures, contain nitrogen and phosphoric acid; in other words, the analyses of these fertilizers.

2. The comparative costs and values of the active fertilizing ingredients in these articles; or, in other words, the commercial valuations.

3. The forms of combination in which the valuable ingredients occur, and their consequent agricultural values.

4. Some of the ways in which the fertilizers may be improved, and their values increased.

In the consideration of these topics, which must be brief, some data will be used which may be found in more detail in previous articles and reports by the writer.*

Explanations of chemical terms used in fertilizer analyses.

307. The following explanations of terms used in fertilizer analyses will be of use to those not familiar with such subjects:

MOISTURE.—All fertilizers contain more or less water, which, of course, has no commercial value, and serves to make them heavier and relatively poorer in valuable ingredients. In the analysis, that which is removed by heating to 212° Fahrenheit (or, in some cases, to a somewhat higher temperature) is designated as moisture. By subjecting the dried material to a higher temperature, the organic and volatile matters are driven off, and the ash remains. By treating this ash with strong acids, all that is of any value is dissolved.

SAND AND INSOLUBLE MATTERS.—The residue, which resists the action of both fire and strong acids, consists of silica and other mineral matters. These possess no fertilizing value, and are classified as sand, &c.

NITROGEN. AMMONIA.—In our ordinary fertilizers much or all of the nitrogen exists in unavailable forms. By more or less rapid alterations, by decay or otherwise, which take place in the soil, these are changed to other compounds, which the plant can readily use as food. Of these latter, nitric acid, which contains nitrogen combined with oxygen, is one; ammonia, which consists of nitrogen and hydrogen, and is represented by the chemical formula NH_3 , is another. Fourteen parts by weight of nitrogen unite with 3 parts of hydrogen to form 17 parts of ammonia. Accordingly, 14 parts of nitrogen are said to be equivalent to 17 of ammonia, or what is the same thing, 100 parts of nitrogen are reckoned as equivalent to 121 parts of ammonia. In pure sulphate of ammonia all the nitrogen is in the form of ammonia. In Peruvian guano some of the nitrogen exists as ammonia also. In our other ordinary fertilizers there is little or no ammonia. The very common practice of reckoning nitrogen as ammonia in fertilizers which do not contain it in this form is incorrect, misleading, and therefore wrong, and ought to be abolished.

Ammonia combined with sulphuric acid forms sulphate of ammonia; nitric acid combined with soda forms nitrate of soda.

PHOSPHORIC ACID: SOLUBLE, REVERTED, AND INSOLUBLE.—By phosphoric acid is understood the compound of phosphorus and oxygen which is represented by the chemical formula P_2O_5 , or PO_5 . This, combined with lime, forms phosphate of lime. The phosphate of lime which

* See particularly report of Conn. Agl. Expt. Station in Report of Conn. Board of Agriculture for 1876.

occurs in bones, and in South Carolina and other fossil and mineral phosphates, contains 3 parts of lime to 1 of phosphoric acid. This is often called bone phosphate, and is insoluble in water. When the bone phosphate is treated with sulphuric acid, the latter takes part of the lime to itself, forming sulphate of lime, and leaves the phosphoric acid in the form of a *superphosphate*. This last is soluble in water, is more readily diffused through the soil, and when used as a fertilizer can be taken up by the plant at once, while the bone phosphate is slowly available as plant food. Phosphoric acid which has been rendered soluble often enters into other forms of combination, with lime, alumina, &c., which, though insoluble in water, are soluble in citrate of ammonia. The terms "reverted," "reduced," and "precipitated" are applied to it when in this form. The reverted phosphoric acid ranks in solubility, in capability of diffusion through the soil, and consequently in value, between the soluble and insoluble. The soluble and reverted are sometimes classed together as available phosphoric acid.

In some analyses the percentage of phosphoric acid is not stated separately, that of "bone phosphate of lime" being given in its stead. Sometimes the expression "soluble bone phosphate of lime" is met with, which is certainly a misnomer. One hundred parts by weight of phosphoric acid unite with about 118 parts of lime to form 218 parts of bone phosphate; 100 parts or pounds of phosphoric acid are said, therefore, to be equivalent to 218 parts of bone phosphate. I lay especial stress on this point, because those not familiar with chemistry are apt to be deceived in comparing analyses in some of which the term phosphoric acid and in others the term bone phosphate is used. It would be more accurate and clear, and in every way better, to discard the term bone phosphate of lime in analyses of fertilizers, and speak only of phosphoric acid.

POTASH, OR POTASSA, is the compound of the metal potassium with oxygen, which is represented by the chemical formula K_2O or KO . This, combined with sulphuric acid, forms sulphate of potash. Potassium and chlorine together form chloride of potassium, or "muriate of potash," as it is called by dealers.

As the analyses and the valuations of the fertilizers to be discussed can be given most concisely and clearly together in tables, explanations of the latter subject may properly be given here.

Valuations of commercial fertilizers.

308. The *agricultural value of a fertilizer*, the gain which will result from its use in a given case, is subject to such varying conditions of soil, climate, culture, and crop, as to preclude the possibility of exact estimate. The *commercial value*, being dependent upon its composition and the state of the market, admits of more nearly correct calculation.

It is customary to make estimates of the commercial values by attributing to each of the important ingredients a certain value per pound;

that is to say, each pound of nitrogen, phosphoric acid, and potash is rated at a certain price, and the value of a ton of the fertilizer calculated on this basis, just as a grocer would make out a bill for a lot of tea, coffee, sugar, by charging a certain price per pound for each, and adding the products to make the amount of the bill. It will be remembered that each per cent. or pound in 100 pounds will be equal to 20 pounds in a ton of 2,000 pounds.

Here, for instance, is an analysis and valuation by Professor Goessmann:

Fish guano.

	Per cent.
Moisture at 100°-110° C	17.50
Organic matter	53.20
Ash constituents	29.30
Phosphoric acid in ash	7.72
Nitrogen in organic matter	6.46
Valuation per ton of 2,000 pounds :	
154.4 pounds of phosphoric acid, at 6 cents per pound	\$9.26
129.2 pounds of nitrogen, at 25 cents per pound	32.30
	<u>\$41.56</u>

The following statements are from the Connecticut experiment station report for 1876.

The statements and tables given in the other parts of this report will supply sufficient data for judging the values of nitrogen, phosphoric acid, and potash in different forms in which they are most commonly obtained in the markets. The commercial value of a fertilizer of which the analysis is given may be calculated by the following rule :

I. Multiply the per cent. of each valuable ingredient by 20 to get the number of pounds in a ton of 2,000 pounds. Multiply the number (thus found) of pounds of each ingredient by its assumed value per pound. The sum of these products will be the estimated commercial value of a ton of the fertilizer. Or,

II. Multiply the number of "units" (per cent.) of each ingredient by the assumed value per unit, and add the products. The sum will be the estimated value per ton.

What will be fair valuations will depend upon the material by which they are furnished, their market value at the time, the amounts purchased, time of payment, distance from market, &c. For the common superphosphates, bought in ton-lots for cash in our larger cities, the following figures will not be far out of the way :

	Per pound.	Per unit.
Nitrogen	21 cents.	\$4 20
Phosphoric acid, soluble	12½ cents.	2 50
Phosphoric acid, reverted	9 cents.	1 80
Phosphoric acid, ins., from bones, meat, or fish	6 cents.	1 20
Phosphoric acid, ins., from bone-black	5 cents.	1 00
Phosphoric acid, ins., from fossil and mineral phosphates	3½ cents.	65

It must be remembered, however, that the values thus calculated are not agricultural values.

The following rates of valuation were adopted by Professor Goessmann in 1874-'75 and 1875-'76:

	1874-'75. Per pound.	1875-'76. Per pound.
Soluble phosphoric acid.....	16.25 cents.	12.5 cents.
Reduced	13 cents.	10 cents.
Insoluble phosphoric acid in mineral phosphates.....	5 cents.	4 cents.
Insoluble phosphoric acid in bones, fish, and animal dust....	6 cents.	6 cents.
Nitrogen	30 cents.	25 cents.
Potassium oxide in muriate	8 cents.	6 cents.
Potassium oxide in sulphate.....	8 cents.	8 cents.

Professor Johnson, in the report of the Connecticut station for 1877, says as follows:

“The following are the trade-values or cost in market, per pound, of the ordinarily occurring forms of nitrogen, phosphoric acid, and potash, as recently found in the New York and New England markets:

	Cents per pound.
Nitrogen in ammonia and nitrates.....	24
Nitrogen in Peruvian guano, fine steamed bone, dried and fine-ground blood, meat, and fish.....	20
Nitrogen in fine-ground bone, horn, and wool dust.....	18
Nitrogen in coarse bone, horn shavings, and fish scrap	15
Phosphoric acid soluble in water.....	12½
Phosphoric acid ‘reverted’ and in Peruvian guano.....	9
Phosphoric acid, insoluble, in fine bone and fish guano.....	7
Phosphoric acid, insoluble, in coarse bone, bone ash, and bone-black.....	5
Phosphoric acid, insoluble, in fine ground rock phosphate.....	3½
Potash in high-grade sulphate.....	9
Potash in kainit as sulphate	7½
Potash in muriate or potassium chloride.....	9

“These ‘estimated values’ are not fixed, but vary with the state of the market, and are from time to time subject to revision. They are not exact to the cent or its fractions, because the same article sells cheaper at commercial or manufacturing centers than in country towns, cheaper in large lots than in small, cheaper for cash than on time. These values are high enough to do no injustice to the dealer, and accurate enough to serve the object of the consumer. * * * The ‘estimated values per pound’ in the above schedule are similar to those employed by Dr. Goessmann and Professor Atwater in their recent reports.”

This method of estimating the commercial values of fertilizers has been long practiced and has its uses, particularly as a forcible means of illustrating frauds, and as the first step in the process of educating farmers and manufacturers. People who are not familiar with chemical terms understand dollars and cents, and are much more impressed by a fertilizers “analyzing” \$30 per ton when the price is \$45, than by its containing only six per cent. of soluble phosphoric acid when it ought to have twelve.

These calculations are, however, open to serious objections, with the rest, because they not only differ very widely from the agricultural

values, but also in many cases decidedly misrepresent the commercial values. It is on this account that they have so generally fallen into disuse or been discarded in England and Germany.

For the present purpose, another method, which has been proposed in the Connecticut station reports, is more fitting. It consists in comparing the different materials by the costs of the ingredients per pound.*

So weighty a matter as this demands full consideration. I therefore give here a table, in which are stated the composition and prevailing market-price per ton, a considerable number of the more important commercial fertilizers in our markets, and the costs per pound of the nitrogen, phosphoric acid, and potash in each at the prices named. Those designated by Arabic numerals were analyzed under the writer's direction. The others are taken from dealers' price-lists. Where several prices are given for the same article, the lower ones apply to smaller and the higher to larger lots.

*See Appendix for details of method of these calculations and for tables of analyses of a number of commercial fertilizers.

Percentages and costs per pound of valuable ingredients of commercial fertilizers.

Fertilizing materials.	PERCENTAGES.						COST PER POUND IN CENTS.										
	Number.	Nitrogen.	Phosphoric acid.				Potash.	Retail price per ton.	Nitrogen.	Phosphoric acid.							
			Available.		Insoluble.	Total.				Soluble.	Reverted.	Insoluble.	Total.				
			Soluble in water.	Soluble in ammonia.										Soluble.	Reverted.	Insoluble.	Total.
NITROGEN.																	
Nitrate of soda, 95 per cent	I	15.65	Per ct.	Per ct.	Per ct.	Per ct.	Dolls.	Cts.	Cts.	Cts.	Potash.	Cts.					
Do	I	15.65					70 00	22 4									
Do	I	15.65					75 00	24 0									
Do	I	15.65					80 00	25 6									
Do	I	15.65					85 00	27 2									
Do	I	15.65					90 00	27 8									
Nitrate of soda, 97.31 per cent	163	16.02					75 00	23 4									
Do	163	16.00					80 00	25 0									
Do	163	16.00					85 00	26 6									
Do	163	16.00					90 00	28 1									
Sulphate of ammonia, 24.29 per cent. ammonia	II	20.00					90 00	23 5									
Do	II	20.00					95 00	23 8									
Do	II	20.00					100 00	25 0									
Do	II	20.00					110 00	27 5									
Sulphate of ammonia, 24.90 per cent. ammonia	3	20.53					97 50	23 8									
Sulphate of ammonia, 24.92 per cent. ammonia	161	20.51					90 00	22 0									
Do	161	20.50					95 00	23 1									
Do	161	20.50					100 00	24 4									
Do	161	20.50					105 00	25 6									
Do	161	20.50					110 00	26 8									
Dried blood (counting phosphoric acid)	160	11.48				1.35	45 00	18 7				7 5					
Dried blood (not counting phosphoric acid)	160	11.48					45 00	19 6									
Do	160	11.50					50 00	21 7									
Dried blood, at \$3.50 per unit for ammonia	III							21 3									
Dried blood, at \$4.50 per unit for ammonia	III							24 28									

Percentages and costs per pound of valuable ingredients of commercial fertilizers—Continued.

Fertilizing materials.		PERCENTAGES.							COST PER POUND IN CENTS.				
		Number.	Nitrogen.	Phosphoric acid.				Potash.	Retail price per ton.	Phosphoric acid.			
				Available.		Insoluble.	Total.			Soluble.	Reverted.	Insoluble.	Total.
				Soluble in water.	Soluble in ammonia.								
PHOSPHORIC ACID—SOLUBLE.													
Dissolved bone-black	IV	Per ct.	13.00	Per ct.	Per ct.	Per ct.	Per ct.	Dolla.	Cts.	Cts.	Cts.		
Do	IV		15.00					33 00					
Do	IV		15.00					35 00					
Do	V		16.50					36 00					
Superphosphate, from South Carolina phosphate	VI		10.50	4.30				30 00		7.0			
Superphosphate, from Canada apatite	VII		15.00					30 00					
Superphosphate, from Philadelphia	VIII		31.60					30 00					
English superphosphate	53		23.25		8.67			65 00		10.5			
								61 00		11.5	4.6		
PHOSPHORIC ACID—INSOLUBLE.													
South Carolina rock phosphate	IX						26.00	20 00			3.8		
Navassa phosphate	45						30.45	20 00			4.9		
Caribbean Sea guano, orchilla	125						27.18	25 00			4.6		
Spent bone-black	X						32.00	26 00			4.1		
Do	X						32.00	30 00			4.7		
POTASH (POTASSA).													
GERMAN POTASH SALTS.													
Sulphate, 65 per cent.	XI							35.15	55 00		7.8		
Do	XI							35.15	60 00		8.5		
Sulphate, 70 per cent.	XII							37.86	60 00		7.9		
Do	XII							37.86	65 00		8.6		
Sulphate, 80 per cent.	XIII							43.26	65 00		7.5		
Do	XIII							43.26	70 00		7.8		
Do	XIII							43.26	75 00		8.1		

[illegible]

Percentages and costs per pound of valuable ingredients of commercial fertilizers—Continued.

Fertilizing materials.	PERCENTAGES.							COST PER POUND IN CENTS.						
	Number.	Nitrogen.	Phosphoric acid.				Potash.	Retail price per ton.	Nitrogen.	Phosphoric acid.				
			Soluble in water.	Soluble in ammonia chloride.	Insoluble.	Total.				Soluble.	Reverted.	Insoluble.	Total.	
Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Dolls.	Cts.	Cts.	Cts.	Cts.					
NITROGEN AND PHOSPHORIC ACID.														
NITROGENOUS SUPERPHOSPHATES—Continued.														
Soluble nitrogenous phosphate, Quininiac Fertilizing Company	101	4.41	7.54		0.46			40 00	22.7	13.6				
Do.	146	3.33	8.16	3.39	2.55			40 00	19.6	11.8		7.8	5.4	
Do.	171	2.49	7.65	2.29	1.91			40 00	23.6	14.2		9.5	5.7	
Average of three samples above									22.0	13.2		8.6	3.3	
Pine Island guano, Quininiac Fertilizing Company	99	5.64	4.95	2.32	1.93			45 00	22.5	13.5		9.0	5.4	
Do.	173	6.25	4.93	0.96	0.84			45 00	23.0	13.8		9.2	5.5	
Average of two samples above									22.7	13.6		9.1	5.4	
FISH MANURES.														
Dry ground fish, Allen's	24	8.80						40 00	17.7					7.1
Do.	185	7.88						40 00	18.1					7.2
Average of two samples, Allen's		8.34						40 00	17.9					7.2
Dry ground fish, Quininiac Fertilizing Company	100	7.50						45 00	22.1					8.8
Do.	140	7.38						45 00	21.9					8.8
Do.	172	7.96						45 00	20.5					8.2
Average of three samples, Quininiac Fertilizing Company		7.61						45 00	21.5					8.6
Dry fish, unground, Green Bros	179	8.60						28 00	10.9					4.4
Half dry fish scrap	103	5.33						16 00	10.2					4.1
Do.	131	5.49						16 00	9.4					3.8
NITROGEN, PHOSPHORIC ACID, AND POTASH.														
PERUVIAN GUANOS.														
Ten per cent. ammonia standard	47	11.33	4.14	8.81	2.42		2.33	60 00	16.0		9.6	6.4	3.8	5.1
Do.	108	8.50	5.95	9.79	2.86		3.24	60 00	17.3		10.4	6.9	4.2	5.5

Do.	137	7.76	5.27	6.24	4.01	4.36	58.50	12.5	11.1	7.4	4.5	5.9
Do.	164	7.52	6.03	5.59	1.39	4.61	57.00	12.9	11.3	7.6	4.3	6.0
Do.	191	7.88	5.11	7.19	3.04	3.54	58.00	12.0	10.8	7.2	4.3	5.7
Average of eight samples as above		8.43	5.10	6.48	3.33	3.60	58.00	17.1	10.2	7.3	4.9	6.5
Guaranteed, cargo A	186	5.87	4.53	4.35	7.10	3.45	56.00	21.3	12.9	8.5	5.1	6.8
Do.	187	5.79	4.59	5.11	7.49	3.36	56.00	20.9	12.5	8.4	5.0	6.7
Average of two samples above								21.1	12.7	8.45	5.55	6.75
Rectified.	57	9.15	10.67		1.71	2.43	60.00	17.9	10.8		4.3	5.7
Do.	136	7.82	10.02	2.82		4.34	65.00	19.9	11.9	8.0		6.4
Average of two samples above								18.9	11.35		4.3	6.05
Peruvian guano, Lobos	243	4.68	6.80	6.08	4.13	4.23	49.00	17.0	10.1	7.3	4.9	6.5
Peruvian guano, No. 2	244	2.60	4.01	7.51	2.12	2.67	39.50	19.8	11.8	8.5	5.7	7.6

Of the above figures it may be remarked :

1. The articles are of the higher grades. The poorer articles with which the markets are infested are not taken into account. The nitrogenous superphosphates, for instance, were among the best of about fifty samples from which the selections were made.

2. The costs of the ingredients vary widely in the different articles. This is illustrated by the following figures, which represent average market-rates :

Fertilizers.*	Costs per pound in cents.			
	Nitrogen.	Phosphoric acid.		Potash.
		Soluble.	Total.	
Nitrate of soda.....	24 to 25	.....	.....	.....
Sulphate of ammonia.....	24 to 25	.....	.....	.....
Dried blood.....	19 to 23	.....	.....	.....
Superphosphates.....	.....	10 to 11	.....	.....
Potash salts, sulphates.....	.....	.....	.....	8
Potash salts, muriates.....	.....	.....	.....	4½ to 5
Slaughter-house refuse.....	.....	.....	.....	.....
Bone manures, best.....	15 to 20	10 to 12	.....	.....
Bone manures, medium.....	10 to 12	.....	5 to 6	.....
Bone manures, inferior.....	14 to 16	.....	7 to 8	.....
Nitrogenous superphosphates, best.....	18 to 24	.....	9 to 12	.....
Nitrogenous superphosphates, medium.....	18 to 21	11 to 13½	.....	.....
Nitrogenous superphosphates, inferior.....	24 to 28	14 to 16	5 to 8	.....
Peruvian guanos.....	30 to 40	18 to 24	6 to 12	.....
Dry ground fish guano.....	17 to 21	10 to 12½	.....	5½ to 6½
Dry fish-scrap.....	18 to 22	.....	7 to 8½	.....
Half-dry fish-scrap.....	10 to 15	.....	4½ to 6	.....
	7½ to 11	.....	3½ to 4½	.....

Relative values of different fertilizers.—Fish and Peruvian guanos.

309. From these figures, which represent a somewhat extensive and thorough survey of the northern and eastern fertilizer markets, it appears that, taking into account composition and price, fish manures furnish the active manurial ingredients, nitrogen and phosphoric acid, at lower rates than any other commercial fertilizers except bone manures. But in bone, the fertilizing ingredients act more slowly. Taking the form of combination, the availability, into account, the nitrogen and phosphoric acid in bone can rival those of fish, only when they are wanted for slow and long-continued use, as in "seeding down" with grass.

Next in order of cheapness come Peruvian guanos. In fairness, however, these ought to be compared only with the dried and finely pulverized fish guanos. Indeed, a pound of nitrogen or phosphoric acid is doubtless worth on the average considerably more, agriculturally, in Peruvian guano than in even the driest and finest fish.

* As was remarked, the nitrogenous superphosphates in the table preceding this were the best of some fifty samples of a large number of brands analyzed at this place. In that list, and in those in the appendix, can be seen the data upon which the above figures are based. The analyses from which the tables are made up were made under the direction of the writer, into whose hands not far from three hundred samples of the commercial fertilizers in the Boston, New York, Philadelphia, and Baltimore markets have lately come for examination. Fraudulent articles are excluded from the computation.

This leads us to consider the values of nitrogen and phosphoric acid in different forms of combination. In general, it may be said that nitrogen is in its most readily available forms in sulphate of ammonia and nitrate of soda; that it becomes quickly useful to the plant in Peruvian guano, more slowly so in fish, dried blood, and meat scraps, and is very long in becoming available in leather scraps, hoof and horn shavings, hair, and the like. Soluble phosphoric acid is ready for use at once. The insoluble phosphoric acid of fish guano, meat, and finely steamed bones, acts more or less quickly, but in coarse pieces of bone and in bone black its action is very slow. In the South Carolina, Nevada, Canada, and other mineral and fossil phosphates, it is of comparatively little value.

The nitrogen and phosphoric acid in coarse fish scraps are less valuable than in fine dry fish, for two reasons: they are more bulky to transport and apply, and are less available to plants when applied.

In 100 pounds of dry guano, there will be say, 10-15 pounds of water, while 100 pounds of half-dry scrap will contain 40-50 pounds of water. To get 100 pounds of dry matter will require on the average, say, 112 pounds of guano and 180 pounds of the half-dry scrap.

Again, the finely ground fish distributed evenly and thoroughly through the soil, is readily decomposed, and thus conveyed where the largest number of roots may have access to it and its materials will be available to the roots when they find it. But the coarse scrap cannot be as well distributed either when it is applied or by natural agencies afterward, less roots will get at it, and when they do find it they will not be able to use it as well as they could the more finely ground and better decomposed guano. Less of the coarse scrap will enure to the benefit of the first crop; and of that which is left over, the phosphoric acid will remain in the soil for subsequent crops, but more or less of the nitrogen will in the process of decomposition be set free and escape into the air, or be leached away by soil-waters beyond the reach of plants, or fixed in unavailable combinations in the soil and thus lost to vegetation.

A great deal has been said about the relative values of fish and Peruvian guano. The following table gives the results of experiments bearing upon this point. The experiments were made upon twenty different beet-sugar farms in and about Germany. The general plan and the details were the same for all. They were carried on by intelligent farmers, under the guidance of Dr. Grouven, director of the experiment station at Salzmünde in Prussia. The figures represent the value in German thalers of the increase in yield over unmanured plots, taking into account not only the increase of the manured crop, but the after effect during two succeeding years. The fish guano was the Norwegian,

which has more nitrogen and much more phosphoric acid than our fish guanos.

Manuring per Prussian morgen.	Gain over unmanured plots, in thaler, per morgen.				Cost of fertilizers per morgen.	Consequent gain from manuring.
	1862.	1863.	1864.	Increase for the three years over unmanured.		
	Fertilizers applied for sugar beets. Average of 20 fields.	No manure; grain and straw; after effect of manuring of 1862. Average of 13 fields.	No manure; sugar beets; after effect of manuring of 1862. Average of 12 fields.			
	Thaler.	Thaler.	Thaler.	Thaler.	Thaler.	Thaler.
1.6 cwt. Peruvian guano.....	12.7	2.9	3.9	19.5	7½	12.0
3.2 cwt. Peruvian guano.....	17.8	4.1	4.0	25.9	15	10.9
6.4 cwt. Peruvian guano.....	23.8	7.7	7.9	39.4	30	9.4
4 cwt. superphosphate.....	8.8	1.3	7.8	17.9	8¾	9.2
6 cwt. superphosphate.....	9.7	2.4	10.1	22.2	13	9.2
8 cwt. superphosphate.....	10.6	1.3	8.9	20.8	17½	3.5
3 cwt. fish guano.....	7.7	0.3	2.5	10.5	9	1.5
6 cwt. fish guano.....	11.1	1.2	3.0	13.3	18	7
1½ cwt. nitrate of soda.....	8.7	0.7	0	9.4	8	1.4
3 cwt. nitrate of soda.....	14.2	1.3	0	15.5	16	—0.5

The German thaler = 72 cents gold, nearly.

The German cwt. or centner = 111 pounds, nearly.

The German morgen = $\frac{2}{3}$ acre, nearly.

Comparing the plots which had 3 cwt. each of fish and Peruvian guano it is to be observed that—

1. The Peruvian guano cost nearly twice as much as the fish guano.
2. The gain from the Peruvian guano, over and above the cost, was six times as much as that from the fish.

These results are remarkably favorable for the Peruvian guano. But it is to be noted that these experiments were on two crops of sugar-beets, with one of grain between. With other crops the results might have been very different.

Stoeckhardt, who has given as much attention to this matter as any one, infers, from a large number of field experiments made under his direction, that the fish guano is very nearly as effective as Peruvian.

Aside from its content of potash, of which fish has as good as none, the greater value of Peruvian guano, which is a fish product, must be due in the main to the fact that, as the result of the changes effected in its passage through the bird and subsequently, the ingredients have entered into new, simpler, and more available forms of combination. Taking into account composition, quality, and price, the cheapest fertilizers in the market are Peruvian guanos; next to these come fish manures.

Ways of improving fish manures.—Fermentation.

310. The advantage of these changes in the composition of fertilizers is much better appreciated in Europe than here. Several ways are recommended to bring them about. One of these is by fermentation.

The increasing importance of fish and bone manures in German agriculture has led Dr. Pagel, of the experiment station at Halle, to undertake a series of experiments to gain light upon the best means of preparing these for use. He recommends very strongly the plan of fermenting them with urine: "The method of fermentation furnishes a most excellent means for transforming the nitrogen in manures of organic origin, which is insoluble and slow in its action, into more soluble and consequently more active forms. It is hence peculiarly applicable to ground-bone and fish guano." He recommends to add about 30 quarts of urine to 100 pounds of bone or guano, and cover the heap with plaster (gypsum) or earth to prevent the escape of ammonia. If this is properly done, the mass will ferment, and the temperature rise to a little above 100° Fahr. The completion of the process, for which three or four weeks should suffice, is indicated by the cooling of the heap. Pagel found nearly one-half the nitrogen of fish to be made soluble in water by this process.

Composting fish fertilizers.

311. Another excellent method of utilizing fish is by composting. I can explain this in no better way than by referring to the experience of one of the most intelligent and successful farmers in our State, Mr. D., who lately called upon me to inquire about this subject. Mr. D.'s problem was simply how to get fertilizing materials for his soil in the best and cheapest manner. He proposed this question:

"I understand that the superphosphate manufacturers make their fertilizers of fish scrap and phosphates, treating them with oil of vitriol to make the phosphoric acid and nitrogen more available. Now can't I accomplish the same by composting in my barn-cellar? I understand the elements must go out of their original combinations into others before they can become useful to my plants, and that the acid and the manufacturing help this change along. I can get fish scrap for \$17 per ton. Can I not bring this change about in a compost-heap, and will it not be a great saving to me?"

The answer was plain: "Fish scrap at \$17 per ton will bring nitrogen at say 10 cents and phosphoric acid at 5 cents per pound. In "ammoniated" superphosphates, you will pay from 20 to 30 cents or more per pound for nitrogen, and from 8 to 20 cents per pound for your phosphoric acid."

"Do I need a phosphate with the scrap; if so, will bone be as good as anything? I can get ground bone from a glue factory at \$30 per ton."

"The bone at that price will give phosphoric acid at say 5 cents and

nitrogen at 10 cents per pound. If rightly composted the ingredients will become available speedily and surely. For most soils and crops the increased proportion of phosphoric acid which the bone would add would be very advantageous."

"I am persuaded that my soil wants potash. Should that be put in the compost; and, if so, what is the cheapest way to get it?"

"If you can get fresh ashes cheap they will do very well. If not, the 'muriate of potash,' which contains 50 per cent. 'actual potash,' and can be bought in the larger markets at \$45 or less per ton, will be best. But the ashes have the advantage over the potash-salt that they supply all the ingredients of plant food but nitrogen, and further, by virtue of their large amount of lime and alkalies, they aid the decomposition of the matters in the compost very materially. In absence of ashes, lime will serve an excellent purpose."

Mr. D. explained his proposed method of composting, which consisted of mixing muck and mellow earth with the fish, bone, potash-salts, and lime, in alternate layers, in heaps where the urine from the stables would be caught and absorbed. From previous experience he believed that he could secure a moderately rapid fermentation which would keep the heap warm, but not too hot, and after a reasonable time have gone so far as to decompose the fragments of fish and bone and leave the whole heap in a well-rotted and uniform condition. I could only say that this seemed to me an extremely rational, sensible, and profitable way of making manure. And I cannot answer the numerous questions I receive about the best way of composting fish for manure any better than by giving the conversation with Mr. D. substantially as I recall it.

Improving fish for manure by feeding it to stock.

312. The most rational method of utilizing fish for manure, and the one which it seems to me must prove by far the most profitable way of economizing our waste fish products, is by feeding them to stock.

European farmers have learned in their practice what science has explained in theory, that just as the most reliable and useful manure is that produced in the stable and barn-yard, so this manure can be vastly improved by foods rich in nitrogen. English, French, and German farmers have found the feeding of oil cake and meal so profitable that manufacturers, entirely unable to meet the demand from the home supply, ransack the markets of Russia, India, and the United States to obtain it. Our linseed and cotton-seed products are in great demand for foreign export. After our oil manufacturers have pressed out the oil, whose value is well enough understood in the commercial world to keep it at home, the press cake, whose worth our farmers have not yet learned, is sent abroad to enrich the cattle food, manure, and purses of foreign farmers who know what it is good for and how to use it.

What gives the value to these waste products is chiefly their nitrogen compounds.

Of late the importance of animal wastes, flesh, meal, dried blood, and fish has come to be understood, and a good many accurate experiments have been made to test their digestibility, their nutritive value, and that of the manure produced from them. This will be explained in the following section, paragraphs 314-325. I will here only refer in few words to the results of a late series of experiments by Wildt, at Proskau, and by Kellner, at Hohenheim, with Norwegian fish guano fed to sheep. It appears that sheep digest the most of the nitrogenous material of the flesh, and a large part of that of the bone. What is not stored away in the body of the animal is excreted as urea, one of the most valuable forms of nitrogen for plant food. Only a small part of the phosphoric acid is digested, but the remainder is left in a very finely divided form, and hence much better for a manure. Kellner discusses the various methods employed for making the ingredients of fish more available for manure. Treatment with acid and caustic alkalies is unsatisfactory. Fermentation with urine is much better; but the most convenient and profitable way he concludes to be that of passing it through the digestive organs of domestic animals.

Practical conclusions.

313. One very great obstacle to the profit from using fish as manure is the fact that it contains only nitrogen, phosphoric acid, and lime, and does not supply the other soil ingredients of plant-food. Where potash is wanted the fish cannot suffice. Illustrations of this are only too abundant. I have only to look out of the window where I write to see in the distance a farm whose proprietor, some time ago, applied fish to one of his fields at the rate of nearly a ton to the acre, hoping to obtain a good crop of hay. In spite of this heavy and costly dressing the grass failed. At my suggestion he tried a series of experiments with different fertilizers to test the deficiencies of his soil. Wherever potash salts were used the crop was good; without potash it failed. The best results were obtained with a "complete" fertilizer, containing nitrogen, phosphoric acid, and potash, such as could be made from fish and potash salts. The recognition of facts like this often makes the difference between good profit and ruinous failure in farming.

The large amount of nitrogen in fish makes it a "stimulating" manure. It helps crops to get more of the food contained in the soil, and thus to "exhaust" the immediately available supply. Farmers often complain that fish, like Peruvian guano, wears out their land. In Maine they talk of land that has been "herringed to death." In Connecticut we often see grasses leaving and sorrel coming in after such fertilizers are used. Some good farmers say their soil gets hard and "caked" after continuous use of fish. The remedies are, tillage and use of other manures, ashes, lime, potash salts, bone, yard manure, muck, and so on.

The nitrogen in fish makes it particularly good for grass and grain, but excess is apt to make grain "run to stalk" and lodge, and may injure or even kill any crop for which it is used.

Besides grain and grass crops, fish does well for corn, potatoes, garden vegetables, etc. It promotes the growth of tobacco, but is thought by many farmers to injure the quality of the leaf.

The fine, dry fish-guano with little oil is the best. The coarse, wet scrap is inconvenient to handle, and cannot be well diffused through the soil. Concentrated fertilizers ought to be thoroughly mixed with the soil so as to be accessible to the largest number of roots and injure none. Neglect to observe this causes immense waste of fertilizing materials and loss of crops. If the coarse scrap is to be used it is best to compost it. The lumps are thus divided, the material decomposed and changed to more available forms, its value for plant-food increased, and it can be applied so as to secure the greatest benefit with the least waste.

Fermentation with urine, as described above, improves fish greatly.

The best method of all for getting fish into forms most fit for plant-food is to feed it to stock. This brings a two-fold advantage: it supplies the nitrogen (protein albuminoids) that poor foods, such as straw, cornstalks, and poor hay lack, and makes excellent fodder from cheap materials, while the nitrogen and phosphoric acid that are not used at the greatest possible profit to make flesh and bone are left in the manure in much better form for plant-food than they were in the fish.

There is great need of improvement in the manufacture of fish manures. What is wanted is a fine, dry product with as little ballast of water and oil and as much nitrogen as possible.

The chief obstacle to the better economizing of fish in agriculture is lack of information as to the best ways of making and using the products. To get this, careful scientific research and close practical observation are indispensable. Investigations in the laboratory and experiments in the field combined will bring the needed knowledge, and it will be worth a hundred times the cost.

52. FISH AS FOOD FOR DOMESTIC ANIMALS.

Principles of animal nutrition.—European experiments.

314. Undoubtedly the manure problem is the most important that the agriculture of our older States has to solve. The next weightiest is the food question, how to best economize and improve our fodder materials. Inside this the most important special problem is how to obtain foods rich in nitrogen. Our feeding materials, taking them together, lack nitrogen. In consequence, our animals are insufficiently fed and fail to get the full benefit of the food they do have. The result is underproduction of meat, dairy products, and work, and in turn poor manure and poor crops. European farmers have passed through this costly

and bitter experience ahead of us, and have learned the cause and the cure. Necessity has driven them to study these problems in ways of whose cost, extent, and beneficent results we on this side of the water have as yet only a faint conception. Hundreds, we might almost say thousands, of feeding experiments have been made with horses, oxen, cows, sheep, goats, swine, and other animals. Some of the ablest chemists and physiologists in Europe are devoting their lives to these special investigations. Governments, universities, agricultural schools, societies, and private individuals are giving money by hundreds of thousands of dollars for the work. In the last ten or fifteen years investigation has been especially active. In twenty agricultural experiment stations, and in a large number of laboratories of universities and other schools, the studies are being carried on to-day, and already definite knowledge has been obtained which many thousands of farmers on the other side of the Atlantic are using to their profit, is beginning to come to us and will, with what must be added by our own efforts, prove of inestimable value to our agriculture.

The lessons our foreign brethren have learned so dearly are free to us if we are wise enough to take and use them. Their substance is briefly this:

The advanced agriculture of the present day looks upon the farm or the stable as a sort of manufacturing establishment. Domestic animals are the machines, food in the form of hay, grain, root crops, commercial food materials, &c., are the raw materials, and meat, milk, wool, labor, and progeny the products.

In cattle-feeding, then, the important question is, how, with the foods at hand or obtainable, to get the most valuable product with the least outlay for raw material.

Feeding for maintenance and production.—Ingredients of foods and their functions.

315. Suppose that I have in my stable a cow, standing idle and giving no milk. She will require only food enough to supply the wastes resulting from the changes that are continually taking place in her internal organism, from the continual building over and renewal of all parts of her body. A certain amount of food of a certain quality is necessary, then, to *maintain* her in good "store" condition. This she will need to "hold her own" when nothing else is required of her.

But suppose that I demand of my cow *production*, say in the form of milk. For this purpose she will need more food. And, as everybody knows, the cow should have for the production of milk, not only a larger quantity, but also different quality of food from that which is needed for maintenance alone.

If, instead of milking my cow, I wish to fat her for the butcher, I shall also require production, but of still another sort, of fat and flesh. And if, instead of a cow, I have an ox that is to be kept at work, yet another

kind of production is required, muscular force. And I need not say that for these different kinds of production different kinds and amounts of fodder are requisite.

In the light of modern experimental science the maintenance of the animal and the production of meat, milk, heat, and force are not matter of so much hay, grain, and roots, but of the gluten, sugar, starch, fat, and so on, of which these are composed.

It has been already explained that animal and vegetable substances are composed of water, organic matters, and ash.

The following is, for instance, what is found in 100 pounds of wheat (grain):

	Pounds.
Water	13.5
Organic substances:	
Gluten, fibrin, &c. (containing nitrogen)	13.2
Starch	59.5
Sugar	2.4
Gum and other extractive matter.....	4.7
Fiber (cellulose)	3.0
Fatty matters (containing no nitrogen)	1.6
Mineral matter (ash)	2.1
Total.....	100.0

Corn, hay, potatoes, in fact vegetables generally, contain nearly the same list of ingredients as wheat, but in different proportions. The same is true of animal foods. Meat and milk consist of similar ingredients.

For our present purpose we have to consider only the organic substance. Now notice in the table above that there is a distinction between two classes of ingredients of this organic substance of wheat. The gluten and fibrin contain nitrogen, while the sugar, starch, fiber, fat, &c., contain no nitrogen.

This distinction between the nitrogenous and non-nitrogenous food ingredients is a fundamental one in economical cattle feeding.

Albumen, found pure in the white of an egg, is a representative of several kinds of substances, which consist chiefly of carbon, oxygen, hydrogen, and nitrogen. To these nitrogenous materials we apply the general name, albuminoids. The albuminoids are found in all animals and plants. Muscle or lean meat, casein (curd) of milk, fibrin of blood, gluten, albumen, and fibrin of plants, are examples. Clover, beans, pease, oil-cake, are rich in albuminoids.

Again, there are other animal and vegetable materials that consist of carbon, oxygen, and hydrogen, simply. These are called carbohydrates and fats. Starch, sugar, gum, and cellulose or fiber are carbohydrates. The oily and fatty matters of plants as well as butter, tallow, &c., are fats. Potatoes, sugar-beets, fodder-corn, and straw are rich in carbohydrates and poor in albuminoids.

The distinctions between the ingredients of the animal tissues and

products are similar. Lean meat or muscle and the casein (curd) of milk, like the albumen of the egg, are albuminoid substances and contain nitrogen. The fat of the body and the fat (butter) in the milk, like the oils and fats of plants, contain no nitrogen.

The ingredients of the body are built up from those of the food. The nitrogenous materials, muscle, connective tissue, skin, &c., are formed from albuminoids. The carbohydrates and fats of the food, which have no nitrogen, cannot be transformed into nitrogenous tissues of the body.

To form the fats, both the fats and albuminoids of the food contribute. A large part of the fat meat stored in the body and of the butter given off with the milk is made and must be made of the albuminoids of the food.

Just what work the carbohydrates do in the animal economy is not yet fully settled. They certainly cannot make flesh, and probably do but little at most to make fat. They act as fuel to keep up the animal heat, and doubtless contribute to the generation of muscular force. Just how much of the heat and force produced in the body comes from the consumption of albuminoids, how much from carbohydrates, and how much from fats is still an unsettled problem.

The animal has been compared to a machine. It is, however, a machine that must be kept running whether it produces anything or not. A horse, or cow, or sheep needs food even at rest in the stall. The machine is peculiar also in that it is wearing out continually and very rapidly, and consumes its own material for both fuel and repairs. The tissues of the body are all the while being used up and rebuilt. In the process of using up, heat and force are produced. The animal consumes food to make its flesh and fat and to give it warmth and strength, but it gets warmth and strength from the consumption of its own flesh and fat at the same time.

Now to make up for the continued wasting away of tissues and to maintain the supply of heat, food is necessary. But for this purpose but little of albuminoids is required. Carbohydrates will serve for fuel to keep the body warm. The horse or sheep at rest will get on with comparatively little nitrogen. Maintenance fodder may be poor in albuminoids if it furnish carbohydrates in plenty. Stock may be kept in the barn and even wintered on poor hay, cornstalks, and straw. But when production is required the case is very different. To make lean meat the animal must have albuminoids. Fat meat may be produced from the fat of the food, if there be enough, but practically a large part of the fat must come from albuminoids. The casein and fat (butter) of the milk likewise come from the albuminoids of the food, and for work also more or less of albuminoids are used. The growing colt or lamb, the working horse or ox, the milch cow and the fattening sheep or swine or steer must all have rich food and food rich in nitrogen. The nitrogenous ingredients, the albuminoids of the food, are its most important constituents. They may take the place of the carbo-

hydrates and fats to considerable extent, but their peculiar work must all be done by themselves. Such is the concurrent testimony of a vast amount of experimenting.

Again, of the whole ration consumed only a portion is digested and used to supply the animal's wants; the rest is voided as excrement, and valuable only for manure. It is important, then, that as much should be digested as possible. The value of the food will depend upon the amount the animal digests from it.

Economy in feeding requires, then, that the greatest amount of food be digested, and that this digested material contain sufficient albuminoids.

An excessive proportion of albuminoids is, however, uneconomical. The albuminoids are the costliest parts of the foods. No more should be used than necessary.

Proper proportions of digestible albuminoids, carbohydrates, and fats in the food are the chief requisites of economical feeding.

Digestion of foods by animals, as tested by European experiments.

316. The digestibility of different foods and food mixtures by different animals under varying circumstances has been tested by a very large number of experiments in the German experiment stations. The method consists in feeding animals with rations of known amount and composition, carefully collecting, weighing, and analyzing the excrements, the undigested portion, and subtracting the latter from the former. The following examples will serve for illustration:

In the stables of the station at Weende, under the direction of Professor Henneberg, two full-grown oxen were fed during one period of about two weeks with oat straw, during another period with bean straw, a third with clover hay, a fourth with meadow hay, and so on. During some of these periods a small amount of bean meal was added. The ration was at all times such as to keep the animals in fair and uniform condition. Careful weighings and analyses were made of fodder and excrement, that is to say, of the total and the undigested material, and from these the digestibility of the food was calculated. For instance, in one of the experiments of this series the ox consumed daily 16.9 pounds of meadow hay, or what is called here "English grasses."

There was contained in—	Organic dry substance.	Consisting of—		
		Albuminoids.	Crude fiber.	Other carbohydrates.
16.9 pounds of meadow hay	<i>Lbs.</i> 14.27	<i>Lbs.</i> 2.12	<i>Lbs.</i> 3.80	<i>Lbs.</i> 6.48
Excrement from same	6.33	.77	1.63	2.06
There was then digested	7.94	1.35	2.17	4.42

In another experiment the daily ration consisted of 17.87 pounds of oat straw, and 1.82 pounds bean meal.

There was contained in—	Organic dry substance.	Consisting of—		
		Albuminoids.	Crude fiber.	Other carbohydrates.
17.87 pounds of oat-straw	<i>Lbs.</i> 14.27	<i>Lbs.</i> 1.12	<i>Lbs.</i> 6.41	<i>Lbs.</i> 6.74
Of this was digested	7.10	.58	3.64	2.88

The first digestion experiments were made some twenty years ago by Henneberg and Stohman, in the experiment station at Weende in Hanover. Their example has been followed in other places. Four years ago the number of digestion experiments amounted to over one thousand, and they have been increasing rapidly in numbers every year since then. These experiments, each one of which has been conducted with an amount of labor and exactness never equaled by a single experiment in this country, have led to many very interesting and weighty results.

What is essential to economy in feeding.—Albuminoids and carbohydrates.

317. The following are among the most important for our present purpose:

1st. Poor foods, like marsh-hay, late-cut hay, straw, cornstalks, and chaff, contain good percentages of digestible material. Their low feeding value is due, not to their lack of nutritive substance, but to its poverty in nitrogen. By adding to them concentrated foods rich in nitrogen, like oil-cake, cotton-seed, bean and pea meal, or nitrogenous animal matters, such as meat scrap and fish, rations are made equal in every respect to the best grass, young-cut hay, or grain.

2d. The digestion of foods, particularly of mixed rations, depends upon the proportions of its constituents. With too little nitrogen the digestion is incomplete. Adding concentrated foods rich in nitrogen to coarse foods promotes digestion. Excess of carbohydrates decreases it. Oil-cake, meat scrap, or fish added to poor hay or straw secures the most complete digestion of the whole ration. But if potatoes or other starchy food are used in considerable quantity the less of the coarse food will be digested.

There is still another principle of great importance to be noted. Well-manured plants are much richer in albuminoids than poorly manured. Bountiful fertilizing not only increases the quantity of the crop but improves its quality also.

The farmer who keeps his land in good condition gets larger yields; the produce contains more digestible substance for his stock, and the nutritive material is richer in the most valuable ingredients of all, the albuminoids.

Composition and valuations of various food materials.—German tables.

318. Fuller details and tables illustrating the principles here presented, may be found in a series of articles on science applied to farming, in the "American Agriculturist" for 1874-'76, and in a lecture on "The Results of Late European Experiments on the Feeding of Cattle," in the report of the Connecticut Board of Agriculture for 1874. A briefer statement of the subject is given by Prof. S. W. Johnson in the report of the Connecticut Agricultural Experiment Station for 1877. This latter contains a table which is interesting as including, with German analyses and valuations, some analyses of American products; with the rest, two samples of fish-scrap. The table is explained by Professor Johnson as follows:

"The following table of the composition, content of digestible nutritive ingredients, and money value of a few of the most important feeding-stuffs, is taken from the German of Dr. Emil Wolff, of the Agricultural Academy at Hohenheim, and represents the most recent and most trustworthy knowledge on these subjects.*

"The composition of feeding-stuffs, as here stated, is the average result of the numerous analyses that have been made within twenty-five years, mostly in the German experiment stations.

"The quantities of digestible ingredients are partly derived from actual feeding experiments and are partly the result of calculation and comparison.

"The percentages of the three classes of digestible matters, viz, albuminoids, carbohydrates, and fat, form the basis for calculating the money value of feeding-stuffs. The values attached to them by Dr. Wolff are the following, the German mark being considered as equal to 24 cents, and the kilogram equal to 2.2 pounds avoirdupois:

"1 pound of digestible albuminoids is worth $4\frac{1}{3}$ cents.

"1 pound of digestible fat is worth $4\frac{1}{3}$ cents.

"1 pound of digestible carbohydrates is worth $\frac{9}{10}$ of a cent.

"These figures express the present relative money values of the respective food-elements in the German markets. Whether or not these values are absolutely those of our markets, they represent presumably the *relative* values of these elements approximately, and we may provisionally employ them for the purpose of comparing together our feeding-stuffs in respect to money value. These money or market values are to a degree independent of the feeding values. That is, if of two kinds of food, for example Hungarian hay and malt sprouts, the one sums up a value of \$0.66 and the other a value of \$1.31 per hundred, it does not follow that the latter is worth for all purposes of feeding twice as much as the former, but it is meant that when both are properly used, one is worth twice as much money as the other. In fertilizers we estimate the nitrogen of ammonia salts at 24 cents per pound, and solu-

* From "*Mentzel u. Lengerke's Kalender*," for 1878.

ble phosphoric acid at 12½ cents; but this means simply that these are equitable market prices for these articles, not that nitrogen is worth twice as much as soluble phosphoric acid for making crops. In the future more exact valuations may be obtained from an extensive review of the resources of our markets, in connection with the results of analyses of the feed and fodder consumed on our farms.

“The column headed ‘Nutritive ratio’ in the table gives the proportion of digestible albuminoids to digestible carbohydrates, inclusive of fat.* * * * To allow of directly comparing the money value of feeding-stuffs with some universally accepted standard, the last column gives a comparison with good average meadow hay taken as 1.”

Average composition, digestibility, and money value of feeding-stuffs, as given by Dr. Wolff for Germany for 1878.*

Feeding-stuffs.	Water.	Ash.	Albuminoids.	Fiber.	Carbohydrates.	Fat.	Digestible mat- ters.			Nutritive ratio.	Money value.	
							Albuminoids.	Carbohydrates.	Fat.		Dollars per 100 pounds.	Comparison with meadow hay = 1.
Meadow hay, inferior.....	14.3	5.0	7.5	33.5	38.2	1.5	3.4	34.9	0.5	10.6	0.48	0.74
Meadow hay, better.....	14.3	5.4	9.2	29.2	39.7	2.0	4.6	36.4	0.6	8.3	0.55	0.86
Meadow hay, average.....	14.3	6.2	9.7	25.3	41.4	2.5	5.4	41.0	1.0	8.0	0.64	1.00
Meadow hay, very good.....	15.0	7.0	11.7	21.9	41.6	2.8	7.4	41.7	1.3	6.1	0.74	1.17
Meadow hay, extra.....	16.0	7.7	13.5	19.3	40.4	3.0	9.2	42.8	1.5	5.1	0.84	1.32
Clover hay, average.....	16.0	5.3	12.3	26.0	38.2	2.2	7.0	38.1	1.2	5.9	0.69	1.08
Clover hay, best.....	16.5	7.0	15.3	22.2	35.8	3.2	10.7	37.6	2.1	4.0	0.88	1.39
Timothy hay.....	14.3	4.5	9.7	22.7	45.8	3.0	5.8	43.4	1.4	8.1	0.69	1.09
Hungarian hay.....	13.4	5.7	10.8	29.4	38.5	2.2	6.1	41.0	0.9	7.1	0.66	1.04
Rye straw.....	14.3	4.1	3.0	44.0	33.3	1.3	0.8	36.5	0.4	46.9	0.35	0.55
Oat straw.....	14.3	4.0	4.0	39.5	36.2	2.0	1.4	40.1	0.7	29.9	0.44	0.69
Rich pasture grass.....	78.2	2.2	4.5	4.0	10.1	1.0	3.4	10.9	0.6	3.6	0.27	0.42
Average meadow grass, fresh.....	70.0	2.1	3.4	10.1	13.4	1.0	1.9	14.2	0.5	8.1	0.22	.36
Green maize, German.....	85.0	1.0	1.2	4.7	7.6	0.5	0.7	7.4	0.2	11.3	.10	.16
<i>Green maize, Mr. Webb, 1874.....</i>	86.0	0.8	0.8	4.8	7.3	0.3	0.6	8.3	0.2	14.4	.11	.17
<i>Oured maize fodder, Mr. Webb.....</i>	27.3	1.2	4.4	25.0	37.9	1.3	3.2	43.4	1.0	14.4	.57	.91
Potatoes.....	75.0	0.9	2.1	1.1	20.7	0.2	2.1	21.8	0.2	10.6	.26	.46
Mangolds.....	83.0	0.8	1.1	0.9	9.1	0.1	1.1	10.0	0.1	9.3	.14	.22
Rutabagas.....	87.0	1.0	1.3	1.1	9.5	0.1	1.3	10.6	0.1	8.3	.15	.24
Sugar beets.....	81.5	0.7	1.0	1.3	15.4	0.1	1.0	16.7	0.1	17.0	.19	.30
Maize, German.....	14.4	1.5	10.0	5.5	62.1	6.5	8.4	60.6	4.8	8.6	1.10	1.73
<i>Maize meal, American, II.....</i>	12.9	1.2	8.7	1.8	71.9	3.5	7.3	68.3	2.6	10.2	1.04	1.69
Oats.....	14.3	2.7	12.0	9.3	55.7	6.0	9.0	13.5	4.7	6.1	.97	1.53
Malt sprouts.....	10.1	7.2	24.3	14.3	42.1	2.1	19.4	45.0	1.7	2.5	1.31	2.06
Wheat bran, coarse.....	12.9	6.6	15.0	10.1	52.2	3.2	12.6	42.6	2.6	3.9	1.04	1.63
Wheat bran, fine.....	13.1	5.4	14.0	8.7	55.0	3.8	11.8	14.3	3.0	4.4	1.03	1.62
Middlings.....	11.5	3.0	13.9	4.8	63.5	3.3	10.8	54.0	2.9	5.7	1.07	1.68
Cotton-seed cake decorticated.....	11.2	7.6	34.8	9.2	19.5	13.7	31.0	18.3	12.3	1.6	2.05	3.22
<i>Fish-scrap, by Goodale's process.....</i>	11.5	.....	61.0	.....	.....	4.6	57.6	.....	4.1	0.2	2.67	4.17
<i>Fish-scrap, dry ground.....</i>	11.7	.....	51.5	.....	.....	8.1	46.4	.....	6.2	0.3	2.28	3.56
Dried blood.....	12.0	4.1	50.8	.....	2.6	0.5	54.1	2.6	0.5	.....	2.39	3.76
Whey.....	92.6	0.7	1.0	.....	5.1	0.6	1.0	5.1	0.6	6.6	.11	.18
Milk.....	87.5	0.7	3.2	.....	5.0	3.6	3.2	5.0	3.6	4.4	.34	.53

* Except those in italics, which are American products analyzed under direction of Professor Johnson.

Comparing the poorer foods, such as straw, cornstalks, and inferior hay with a good standard food like the best hay or pasture grass, it appears that the great difference is that the former lack albuminoids, just what bran, oil cake, cottonseed cake, and especially fish, supply. One

* Fat and carbohydrates have, it is believed, similar nutritive functions, and it is assumed that 1 part of fat equals 2.4 of carbohydrates.

hundred pounds of the fish scrap made by Goodale's process added to 900 lbs. of the poorest hay would make a mixture equal in composition to 1,000 pounds of the best hay. Three hundred pounds of the same fish-food with 1,700 lbs. of oat straw would be equal to a ton of the best hay.

It is clear, then, that what our farming wants, to make stock-raising profitable, manure plenty and rich, and crops large and nutritious, is nitrogenous material for foods.

One of the cheapest, most useful, and best forms in which this can be furnished is in fish products. In proof of this we have the testimony of both extensive experience and accurate experimenting.

Experience in use of fish as food for stock.—Feeding cattle on fish in Massachusetts.

319. The earliest account which I have met of fish as food for domestic animals is the following extract from the Barnstable [Mass.] "Journal," of February 7, 1833:

"Feeding cattle on fish.—The cattle at Provincetown feed upon fish with apparently as good relish as upon the best kinds of fodder. It is said that some cows, kept there several years, will, when grain and fish are placed before them at the same time, prefer the later, eating the whole of the fish before they touch the grain. Like one of old, we were rather incredulous on this subject, till we had the evidence of ocular demonstration. We have seen the cows at that place boldly enter the surf, in pursuit of the offals thrown from the fish-boats on the shore, and when obtained, masticate and swallow every part except the hardest bones. A Provincetown cow will dissect the head of a cod with wonderful celerity. She places one foot upon a part of it, and with her teeth tears off the skin and gristly parts, and in a few moments nothing is left but the bones."

The inhabitants of Provincetown are not the only people who feed their cattle upon fish. The nations of the Coromandel coast, as well as in the other parts of the East, practice feeding their flocks and herds with fish. The celebrated traveler, Ibu Batuta, who visited Zafar, the most easterly city in Yemen, in the early part of the fourteenth century, says that the inhabitants of that city carried on a great trade in horses in India, and at that period fed their flocks and herds with fish, a practice which he says he had nowhere else observed.

Experiment of Mr. Lawes, in England, with fish as food for swine.

320. In 1853 Mr. J. B. Lawes, of Rothamshead, England, reported several extensive series of experiments "On the Feeding of Pigs," in which were tested the effects of bean, lentil, Indian corn, and barley meals, bran, and dried Newfoundland codfish as foods for fattening and making manure. In speaking of the series in which the fish was fed with maize, barley, and bran in different proportions, Mr. Lawes says:

"In the series * * * where we have * * * a comparatively

small amount of non-nitrogenous matter consumed, the food consisted in a large proportion of the highly nitrogenous codfish; and in both of these cases we had not only a very good proportion of increase to food consumed, but the pigs in these pens were very fat and well ripened; and hence a large proportion of their increase would be real dry substance. * * * This result is in itself interesting, and it may perhaps point to a comparatively greater efficiency in the already animalized proteine compounds supplied in the codfish than in those derived, as in the other cases, from the purely vegetable diets.”*

Other European experience.

321. In 1856 Professor Stoeckhardt, of Tharand, Saxony, who was one of the first chemists to recognize the value of fish guano, and has done more than any other one in Europe to encourage its manufacture and use, received a sample from Norway, which, as he says, “looked so inviting that I tried it for fodder also.” He fed it to a half-year-old pig, which “did exceptionally well on this northern food.”

In the northern part of Norway, when during the long winters the supply of hay and straw gives out, cattle are fed upon dried fish. They do poorly on this diet alone, of course, but recover very quickly when the spring pasturage comes.†

Success of Maine farmers in feeding fish to sheep.

322. The value of fish as food for domestic animals has been attested by experience of intelligent farmers in our own country, as is illustrated by the following extracts from Boardman and Atkins’ report, from which so many quotations have already been made :

“As early as 1864, if not in fact previous to that date, the attention of members of the board of agriculture [of Maine], and farmers generally, was called to the matter of the value of fish pomace or scrap as a feeding stuff for sheep, swine, and poultry. In a communication to the board‡ Mr. William D. Dana, of Perry, spoke in high terms of its value as a feed for domestic animals, in which he said : ‘Fish pomace, or the residuum of herring after the oil is pressed out, is greedily eaten by sheep, swine, and fowl; and probably pogy chum would be eaten as well. Smoked alewives and frost fish also furnish a food palatable to cattle. Sheep thrive well, get fat, and yield heavier fleeces when fed on this pomace than when fed on anything else produced in this section of the State. Careful and observing farmers, who have fed it, assert that it is of equal value with good hay, ton per ton, and that its value for manure is in no degree diminished by passing it through the living mill, and thus reducing it to a much more convenient state for applying. It it could be sufficiently dried, without other substances, to prevent putre-

* Jour. Roy. Ag. Soc., 1st Ser. XIV, 1853, p. 527.

† Meinert. Travels in Norway. Chem. Ack., 1870, xi, p. 45.

‡ Agriculture of Maine, 1864, p. 43.

faction, it would form a valuable article of cattle-feed in regions from which it is now excluded by the expense of transportation and its own odoriferous nature.'

"In remarking upon this the secretary of the board said that if sheep would eat the scrap readily, much poor hay or straw could be used to good advantage, thus allowing the farmer to consume all his first-quality hay in keeping other stock. He thought the meat would not taste of the flavor imparted by the scrap, provided other food was substituted for a proper length of time before slaughtering.

"From time to time following this, the matter was discussed before the board, and formed the subject of many articles in the agricultural journals. In 1869, Mr. M. L. Wilder,* of Pembroke, then a member of the board, presented a brief paper embodying his experience in the use of scrap as a feed for sheep, in which he said he believed 'fish offal to be not only cheaper, but much superior to any other kind of provender he had ever used' for this purpose. An extract from his paper is given: 'I keep about one hundred sheep, and have fed fish offal to them for the past ten years. The offal is made from herring caught in weirs, salted the same as for smoking, cooked, and the oil pressed out, leaving a pomace for which the sheep are more eager than for grain. For the last three winters I have kept my sheep on threshed straw with one-half pound per day to each sheep of dried fish pomace, or one pound of green (as it shrinks one-half in drying), and they came out in the spring in much better condition than when fed on good English hay with corn. I consider the dry pomace worth as much as corn, pound for pound. When I have had enough to give them one-half pound per day, I have found that the weight of the fleece was increased one-quarter, and not only that but also the carcass in a like proportion; the weight of the fleeces per head averaging from five to seven pounds.'

"Similar statements to the above were made by Hon. Samuel Wasson† and other gentlemen, not only at public meetings of the board, but through the press, so that the subject has been kept alive and invested with some interest down to the present time.

Experiments of Professor Farrington on fish scrap vs. corn meal as food for sheep.

"323. Wishing to test the value of scrap as a feed with more care than had apparently attended any of the trials that had been reported, and also wishing to make a sort of competitive trial of it in connection with corn, a quantity was obtained for this purpose of Mr. M. L. Wilder, of Pembroke. It was herring scrap, salted before the oil was expressed, and packed in barrels directly from the press, each barrel containing about 220 pounds. Its cost in Augusta, including freight from Pembroke via Portland, was not far from \$2 per barrel.

*Agriculture of Maine, 1869, p. 60.

†Agriculture of Maine, 1874-'75, p. 1.

"This scrap was placed in the hands of Mr. J. R. Farrington, the instructor in agriculture at the State College, Orono, with the request that he would feed it to sheep in connection with Indian corn in such way as would best serve the purpose of ascertaining its comparative value as a provender or feed. Few instructions were given him, and he being left to carry out the experiment in his own way—and public acknowledgment should here be made for his interest in undertaking the matter, and for the care and faithfulness with which the experiment was conducted. The report of Mr. Farrington follows:

"The statement made by a prominent agriculturist that for feeding sheep fish chum was equal to corn, pound for pound, furnished the basis for the experiment which we conducted to ascertain the comparative value of corn and fish chum when fed to sheep. Ten lambs, dropped the previous spring, were selected; each one was designated by a number, the number being stamped on a metallic tag and attached by a copper wire to the ear of the lamb; Nos. 1, 2, 3, 4, and 5 constituted flock 1; Nos. 6, 7, 8, 9, and 10, flock 2. We began feeding January 15, 1875. Flock No. 1 was fed with corn; flock No. 2 was fed with fish. Each flock was given what good hay it would eat. The hay fed to each flock during the month (four weeks) beginning February 13 was weighed. Flock No. 1 ate, in four weeks, 335 pounds; flock No. 2 ate 338 pounds.

"At commencement of feeding, January 15, 1875:

Flock No. 1 weighed as follows:		Flock No. 2 weighed as follows:	
Sheep No. 1 weighed.....	46 lbs.	Sheep No. 6 weighed.....	49 lbs.
" 2 ".....	77 "	" 7 ".....	74 "
" 3 ".....	67 "	" 8 ".....	68½ "
" 4 ".....	55 "	" 9 ".....	67 "
" 5 ".....	63 "	" 10 ".....	58 "
Weight of flock, Jan. 15.....	313 "	Weight of flock, Jan. 15.....	316½ "
During four weeks ending February 13, 18½ pounds of corn were fed to flock No. 1. At this date—		During four weeks ending February 13, 18½ pounds of fish were fed to flock No. 2. At this date—	
Sheep No. 1 weighed.....	50 lbs., a gain of 4 lbs.	Sheep No. 6 weighed.....	52 lbs., a gain of 3 lbs.
" 2 ".....	81½ " 4½ "	" 7 ".....	81 " 7 "
" 3 ".....	73 " 6 "	" 8 ".....	72½ " 4 "
" 4 ".....	59 " 4 "	" 9 ".....	68 " 1 "
" 5 ".....	77 " 9 "	" 10 ".....	64½ " 6½ "
Weight, February 13.....	340½ " 27½ "	Weight, February 13.....	338 " 21½ "
During four weeks ending March 12, 20 pounds of corn and 335 pounds of hay were fed flock No. 1. At this date—		During four weeks ending March 12, 20 pounds of fish and 338 lbs. of hay were fed flock No. 2. At this date—	
Sheep No. 1 weighed.....	50½ lbs., a gain of ½ lbs.	Sheep No. 6 weighed.....	55½ lbs., a gain of 3½ lbs.
" 2 ".....	75½ lbs., a loss of 6 "	" 7 ".....	79 lbs., a loss of 2 "
" 3 ".....	69 " 4 "	" 8 ".....	71½ " 1 "
" 4 ".....	56½ " 2½ "	" 9 ".....	67½ " ½ "
" 5 ".....	70 " 7 "	" 10 ".....	63 " 1½ "
Weight of flock.....	321½ " 19 "	Weight of flock.....	336½ " 1½ "

During the above four weeks the *corn-fed flock*, weighing 340½ pounds, ate 335 pounds of hay and lost 19 pounds in weight. The flock eating fish, weighing 338 pounds, ate 338 pounds hay and lost 1½ pounds.

During four weeks ending April 9, 19 pounds corn were fed flock No. 1. At this date—		During four weeks ending April 9, 19 pounds of fish were fed flock No. 2. At this date—	
Sheep No. 1 weighed	51 lbs., a gain of ½ lbs.	Sheep No. 6 weighed.....	62 lbs., a gain of 6½ lbs.
" 2 ".....	76½ " 1 "	" 7 ".....	84 " 5 "
" 3 ".....	75½ " 6½ "	" 8 ".....	75 " 3½ "
" 4 ".....	64½ " 8 "	" 9 ".....	71 " 3½ "
" 5 ".....	78½ " 8½ "	" 10 ".....	65 " 2 "
Weight of flock.....	346 " 24½ "	Weight of flock.....	357 " 20½ "

During four weeks ending May 7, 15 pounds of corn were fed flock No. 1. At this date—

Sheep No. 1 weighed.....	55 lbs., a gain of 4 lbs.
“ 2 “ “ “ “ “	79 “ “ 2½ “
“ 3 “ “ “ “ “	80 “ “ 4½ “
“ 4 “ “ “ “ “	65 “ “ 3 “
“ 5 “ “ “ “ “	82 “ “ 3½ “

Weight of flock..... 361 “ 15 “

During four weeks ending May 7, 15 pounds of fish were fed flock No. 2. At this date—

Sheep No. 6 weighed.....	62 lbs., a gain of 0 lbs.
“ 7 “ “ “ “ “	87 “ “ 3 “
“ 8 “ “ “ “ “	75 “ “ 0 “
“ 9 “ “ “ “ “	73 “ “ 2 “
“ 10 “ “ “ “ “	67 “ “ 2 “

Weight of flock..... 364 “ 7 “

Recapitulation.—During the sixteen weeks of the experiment—

Sheep No. 1 gained.....	9 lbs.
“ 2 “ “ “ “ “	2 “
“ 3 “ “ “ “ “	13 “
“ 4 “ “ “ “ “	10 “
“ 5 “ “ “ “ “	14 “

Flock No. 1 gained..... 48 “

Fed with corn—weighing, January 15, 313 pounds.
Gained 48 pounds, or 15½ per cent.

Sheep No. 6 gained.....	13 lbs.
“ 7 “ “ “ “ “	13 “
“ 8 “ “ “ “ “	6½ “
“ 9 “ “ “ “ “	6 “
“ 10 “ “ “ “ “	6 “

Flock No. 2 gained..... 47½ “

On fish—weighing, January 15, 316½ pounds.
Gained 47½ pounds, or 15¼ per cent.

That is to say, the corn-fed flock gained 48 pounds, and the fish-fed flock 47½ pounds during the sixteen weeks of the experiment.

Professor Farrington has courteously favored me with some further, but as yet unpublished, details of his experiments. The fish scrap from herring was unground and some of the fragments were rather coarse. It was hard to get the sheep to eat much of the fish, though they gradually learned to like it better. This accounts for the very small quantity consumed.

A second trial similar to the above was made the succeeding winter, and with like results, except that the sheep ate rather more of the fish. In one case a flock of four consumed 28 pounds in four weeks, which is equivalent to 4 ounces per head per day, while in the above series they averaged only about 2 ounces per head per day. The meal was regulated by the amount of fish consumed. The quantities of both were thus extremely small. It is to be noted, however, that the sheep had “all the good hay they would eat.” The fish was distasteful, and they took very little. If they had received a fixed quantity of staw, cornstalks, or poor hay, instead of good hay *ad libitum*, they could doubtless have been got to eat more fish, and would probably have learned to like it.

Mr. Wilder, of Pembroke, whose statements were quoted above, and who furnished the scrap for Professor Farrington’s experiments, “keeps about one hundred sheep * * * on threshed straw with one-half pound per day to each sheep of dried fish pomace * *, for which the sheep are more eager than they are for grain * * *, and they come out in the spring much better than when fed on good English hay with corn.”

Professor Farrington agrees with me in the opinion, indeed the experience of farmers who have fed fish successfully leaves room for no other, and the European experimenters quoted below say the same thing, that sheep, swine, and probably neat cattle, can be taught to eat fish, and when once wanted to it will take it with excellent relish.

A dry, well-prepared, and finely-ground product, such as may be made by the Goodale or other processes, would doubtless keep better, be more free from offensive odor and taste, and worth much more for feeding than the ordinary scrap.

European experiments on digestion and nutritive value of fish, meat-scrap, etc.

324. The need and value of nitrogenous foods for food mixtures, explained and attested by science and confirmed by experience in Europe, has led to diligent seeking, careful trial, and rational use of available foods from every source. Of late a great deal of attention has been paid to animal products. The flesh meal left from the preparation of "Liebig's Meat Extract" in South America, the dried blood of slaughter-houses, and fish guano have all been tested and found extremely valuable.

The scope of the present article precludes details of the experiments on the digestibility and nutritive value of animal foods for stock; I therefore reserve them for a future occasion, and note briefly here some of the main results.

The following are among the experiments of this sort reported in the years 1876 and 1877. The original accounts are in "Die landwirthschaftlichen Versuchs-Stationen," the "Journal für Landwirthschaft," and the "Landwirthschaftliche Jahrbücher" for those years:

Experimenters.	Experiment stations.	Animals.	Food.
I. Wolff, and associates	Hohenheim ..	Swine...	South American flesh meal and potatoes.
II. Wolff, and associates	do	do	Flesh meal, pea meal, potatoes, and starch.
III. Wildt	Kuschen	Sheep ..	Blood meal, flesh meal, and barley straw.
IV. Wildt	do	Swine ..	Blood meal, pease, and potatoes.
V. Weiske, and associates	Proskau	Sheep ..	Fish guano.
VI. Kellner, and associates	Hohenheim ..	do	Fish guano, Lucern hay, and oatmeal.

The general plan of each of these experiments was to feed the animals during different periods of two or three weeks each with different foods and mixtures, and to note, by careful weighings and analyses of foods and excrements, the amounts digested. The most prominent of the questions has been the comparative digestibility and nutritive value of vegetable and animal albuminoids. As a general result the albuminoids and fats of meat, blood, and fish are found to be as digestible or more so than those of the most concentrated vegetable foods.

In I, Wolff found swine to digest from albuminoids 92 parts and fats 97 parts out of every 100 parts of each in the flesh meal, and concludes that flesh meal is an easily digested and intensely nutritious food.

In II, Wolff found that the albuminoids in pease and fleshmeal had essentially the same effect.

From III, Wildt found some difficulty in getting sheep to eat the blood and flesh. He says that potatoes and roots will help to make the flesh and blood palatable, and thinks that these may be used with profit to supply albuminoids to herbivorous animals.

From IV, Wildt concludes that animal albuminoids may serve just as well as vegetable for supplying nitrogen to foods poor in albuminoids.

From V and VI, Weiske and Kellner conclude that fish guano, like meat and blood, may be fed with profit to herbivorous animals. In Kellner's experiment two two-year old wethers were fed during the first period with Lucern hay. During the second part the hay was replaced by

oatmeal, and during the third Norwegian fish guano was added to the ration of the second period. At first the animals did not like the fish, but on mixing it well with the oatmeal they accepted it more readily. At the close of the experiment they had got to liking the guano so much as to eat it greedily with no admixture of other foods. They digested on average of two experiments 90 per cent. of the albuminoids and 76 per cent. of the fat of the guano. Concerning the nitrogenous matter of the bone, Kellner made the same observation as has been previously noted, namely, that it was quite rapidly digestible. It is particularly worthy of remark that the Norwegian fish guano which was used in this experiment had 9.44 per cent. nitrogen and no less than 15.77 per cent. phosphoric acid, and only 2.11 per cent. fat. That is, it had more bone than our fish guano. This is because it is made not of the whole fish, but of the refuse heads, entrails, and bones. The most of the fat had been removed by the steaming process used in preparation of the guano.

General conclusions concerning fish as food for domestic animals.

325. On the whole, then, these experiments bear unanimous and convincing testimony in favor of the easy digestibility and high nutritive value of animal foods in general and of fish guano in particular when fed to sheep and swine.

How far they could be made profitable for other herbivorous animals than sheep has not yet been tested. In the nature of the case there is no reason why they should not be as nutritious for neat cattle as for sheep. As Voit has justly observed, all mammals are at one period of their lives, when living upon milk, carnivorous. Late investigations have shown very clearly that even plants are positively nourished by animal foods. The very interesting experiments of Mr. Francis Darwin with the round-leaved sundew demonstrate conclusively that plants may thrive on a meat diet.

In short, we have every reason, from practical experience, from actual experiment, and from what we know of the nature of the case, to believe that the immense amount of animal waste produced in this country from our slaughter-houses, and especially from our fisheries, can be utilized with the greatest ease and profit to supply the most pressing need of a most important part of our agriculture, nitrogenous food for stock.

We have seen that farmers in New England and in Europe have found fish good for their stock, that occasionally one like Mr. Wilder has hit upon a rational way of using it to piece out and improve the poorer products of their farms, and that patient research has explained why it is useful and how it may be made more so. This is one of the countless cases where practical men have worked their way in the dark by the tortuous path of experience to the same results to which scientific investigation leads. But here as ever the results when found need the light of science to explain the facts and make it possible to apply them most profitably.

53. SUMMARY.

Fish as manure.

326. The following is a brief recapitulation of the main points urged in this article:

1. The value of fish as manure is due mainly to its nitrogen and phosphoric acid.

2. Taking into account composition, quality, and price, fish manures furnish these ingredients more cheaply than any other class of fertilizers in the market except Peruvian guanos.

3. The crops most benefited by fish manures are those which need considerable nitrogen and phosphoric acid, but are not especially helped by mineral manures alone. Such are grass, grain, and corn. The same is generally true of potatoes and garden vegetables, and sometimes of roots. Leguminous crops, like clover, beans, and pease, are more benefited by mineral manures, and get little good from the nitrogen of the fish.

4. Fish manures are quick and stimulating in their action. Their force is soon spent and they often leave the soil in worse condition than before they were applied. This is, however, no argument against their value. The remedy for such cases is to apply other materials, as ashes, lime, potash salts, dung, muck, etc., with them.

5. The proper soils for fish manures are those which are deficient in nitrogen and phosphoric acid, and in which the stimulating effect of the decomposition of fish may render other materials available for plant food. Soils that have been treated repeatedly with fish, guano, phosphates, and bone are often overstocked with these ingredients and deficient in potash. Many soils are originally poor in potash. To apply fish on such soils and omit the lacking elements is to lose both fertilizer and crop. The deficiencies of a given soil are best told by actual trial, with different manures and crops.

6. The general usefulness of fish manures will be increased by adding to them phosphoric acid, in the form of bone or superphosphates, and potash in German potash salts. Fine steamed bone, that can be bought for \$32 to \$45 per ton, or "plain" superphosphates, made from South Carolina or Canada phosphates, and sold at \$30 to \$32 per ton, are economical sources of phosphoric acid. The "50 per cent. muriate," sold at about \$40 per ton, is one of the cheapest grades of potash salts. Of the "ammoniated" superphosphates, a very few of the best brands are sold at cheaper rates than it would cost the farmer to make them. But instead of buying medium and inferior articles, farmers will do better to buy the materials and mix them at home.

7. The best form of fish manures is the dry-ground fish guano freed from oil. The water and oil add weight and bulk without increasing value. The coarse fish-scrap cannot be thoroughly spread, is not easily diffused by the water in the soil, is reached by few roots, and becomes slowly

available to the roots that find it. But the fine dry fish is easily spread, is diffused by rain, is thus made accessible to a large number of roots, and can be absorbed by them when they reach it.

8. The ingredients of fish may be made more available for plant-food and their value for manure increased by—

a. Fermentation with urine.

b. Composting with muck, earth, ashes, lime, bone, potash salts, and farm-refuse of all sorts.

c. Feeding to stock, thus putting it through a process similar to that by which Peruvian guano has been formed. In this way it can be used to enrich the manure made on the farm, and thus made one of the best aids to successful farming.

Fish as food for stock.

9. The chief defect of our fodder materials as a whole is their lack of nitrogen. From poor manuring our crops are not only small in quantity, but poor in quality. They lack nitrogen. This is true of our forage crops in general, and of poor hay, straw, and corn-stalks in particular. What our farming most wants, to make stock-feeding profitable, manure plenty and rich, and crops large and nutritious, is nitrogen.

10. One of the cheapest, most useful, and best forms in which this can be furnished is in fish products. These have been found very profitable for feeding in Europe. Our fish guanos are better than the European for this purpose, because they have more flesh and less bone.

The loss to our agriculture from waste of fish.—The evil.

11. Millions of pounds of fish not fit for human food are allowed every year to escape from nets into the sea, which, if saved and rightly utilized, would be worth untold sums for fertilizers and feeding materials.

12. Of the fish saved and used for fertilizers, a large portion is ill-prepared.

13. A large part of that which is well made is exported to Europe, where its value is better understood, and its use is more rational and profitable.

14. A great deal of the fish manure that gets into farmers' hands, be it well or ill prepared, is wasted by wrong application, and by use where it does not fit the needs of crop and soil.

15. A still greater loss comes from the neglect to use fish as food for domestic animals.

16. The total loss to our agriculture from all these sources is not capable of accurate computation, but amounts certainly to hundreds of thousands, and doubtless millions of dollars annually.

The remedy.

17. As the main source of the evil is ignorance, the chief reliance for cure must be in better understanding of the facts and the ways to improve.

18. The needed knowledge can be gained from two sources. The results of European experience and experimenting will be one; experiments and investigations of our own products in our own laboratories, fields, and stables, another. The knowledge once obtained and set forth in detailed reports will, in the natural course of things, be condensed and diffused through the agricultural press, and applied by manufacturers and farmers, to the great benefit of all.

19. The compilation of results of foreign work can be made by reference to the numerous German, French, and English scientific and agricultural journals through which the original memoirs are scattered.

20. The investigations would be properly divided into those on fish as manure and those on fish as food for animals.

21. The experiments on fish as manures would probably be made—

1. In the laboratory, and consist of: *a*, analyses of fish products; *b*, investigations on their changes in composition and action in the soil.
2. In the field, and consist of rationally planned and carefully conducted trials with different fertilizing materials, including fish manures, on different soils and with different crops, in order to obtain specific answers to specific questions whose solution is important.

22. The experiments on fish as food for stock should be made—

1. On farms, by feeding out fish with ordinary foods in simple ways, as was done by Professor Farrington at the Maine State College.
2. In stables fitted up for trials with simultaneous laboratory work, on the plan of the European experiments, above described. The object of these trials would be to determine the digestibility and nutritive effect of the materials employed.

The urgent need of popular instruction.

327. Here is a case where men with the best intentions in the world, fishermen, manufacturers, and farmers, are suffering the waste of thousands, and even millions of dollars' worth of material, bitterly needed to supply the wants of worn-out soils and make bread and meat for hungry men. The first step toward stopping this must be the getting of information. In Europe, governments, agricultural schools, societies, and experiment stations would, in fact do, grapple the questions, and with the best talent, aided by the best appliances that ingenuity, enthusiasm, and money can procure, work at them until they are solved. But here, we shall not get the needed knowledge until some educational institution, experiment station, or other agency, takes hold of the work with a will and put it through.

APPENDIX A.

CIRCULAR RELATING TO "STATISTICS OF THE MENHADEN FISHERY."

OFFICE UNITED STATES COMMISSIONER OF FISH AND FISHERIES,
Washington, D. C.

Among the most important of the marine fishes of the coast of the United States is the species known as the Mossbunker about Long Island and New Jersey; bony-fish and menhaden on the south coast of New England; and pogy (not porgy) on the eastern coast; elsewhere as the bug-fish, yellow-tail, &c., and by naturalists as *Brevoortia menhaden*. Generally considered unfit for food, it is principally captured for bait or for its oil, and for the scrap or refuse left after the oil is squeezed out by means of the hydraulic press.

It is considered very desirable to obtain as full an account as possible of the habits, migrations, &c., of this fish, as well as complete statistics of its capture and uses. I therefore beg leave to call attention to the following queries, and to request answers to as many as practicable. It is not necessary to repeat the queries, a reference to the number affixed to the question being sufficient. Replies should be made on foolscap paper, if equally convenient, and written on one side only of the page.

The information thus obtained will be embodied in a report to Congress, in which full credit will be given to all contributors.

SPENCER F. BAIRD,
Commissioner.

SMITHSONIAN INSTITUTION, *December 20, 1873.*

A.—NAME.

1. By what name is this species known in your vicinity?

B.—ABUNDANCE.

2. How does this fish compare in abundance with others found in your vicinity?
3. Has it diminished or increased in numbers within the last ten years?
4. What was the number of barrels taken in 1873 by any or all establishments in your vicinity—naming them, if possible? Give the same facts for any other year.
5. Does the extensive capture affect their abundance?

C.—MIGRATION AND MOVEMENTS.

6. When are the fish first seen or known to come near the coast, and when does the main body arrive; are the first the largest; are there more schools or runs than one coming in, and at what intervals?

7. Do the schools of fish swim high or low, and is their arrival known otherwise than by their capture—that is, do they make a ripple on the water; do they attract birds, &c.?

8. By what route do these fish come in to the coast, and what the subsequent movements?

9. Is the appearance of the fish on the coast regular and certain, or do they ever fail for one or more seasons at a time, and then return in greater abundance; if so, to what cause is this assigned?

10. Does the use of nets, seines, &c., used in catching them, tend to scare them farther from the shore, their usual feeding grounds?

11. What is the relation of their movements to the ebb and flow of the tide?

12. What are the favorite localities of these fish?

13. What depth of water is preferred by these fish, and how low do they swim?

14. Does the temperature of the water appear to affect them?

15. Do these fish come on to the breeding grounds before they are mature, and do you find the one or two year old fish with the oldest?

16. Are young fish ever seen on the coast; if so, when, and of what size?

17. When do the fish leave the coast, and is this done by degrees or in a body?

18. By what route do they leave the coast?

19. Where do they spend the winter season?

D.—FOOD.

20. What is the nature of their food?

E.—REPRODUCTION.

21. Where do these fish spawn and when?

22. Can you give any account of the process, whether males and females go in pairs, or one female and two males; whether the sexes are mixed indiscriminately, etc.?

23. Is the water whitened or colored by the milt of the males?

24. What temperature of water is most favorable for spawning?

25. At what depth of water are the eggs laid, if on or near the bottom?

26. Do the eggs, when spawned, sink to the bottom and become attached to stones, grass, &c., or do they float in the water until hatched?

27. When are the eggs hatched, and in what period of time after being laid?

28. Are the young of this fish found in abundance and in what localities?

29. Is the spawn ever found to run from the fish when handled after capture?

F.—ENEMIES AND FATALITIES.

30. What enemies interfere with or destroy the spawn or the young fish ; do the parent fish devour them ?

31. Are crabs, worms, lampreys, or other living animals found attached to the outside, or on the gills, or in the mouth, especially the roof of the mouth ?

32. To what extent do they suffer from the attacks of other fish or other animals—as sharks, blue-fish, porpoises, &c. ?

33. Has any epidemic or other disease ever been noticed among them, such as to cause their sickness or death in greater or less numbers ?

G.—CAPTURE.

34. What kind of nets are used in the capture of this fish ?

35. What are the dimensions (length and depth) of the nets used ?

36. What kind of vessels are employed and what is the tonnage ?

37. What is the number of men required for the management of vessel and nets ?

38. What part of each day is employed in fishing ?

39. Are the fish taken more on one tide than another ?

40. Does the wind have an effect on them ?

41. What is the number of vessels employed in your vicinity and what is the aggregate number of their crews ?

H.—ECONOMICAL VALUE AND APPLICATION.

42. What disposition is made of the fish caught ; whether used on the spot or sent elsewhere ; and, if so, where ?

43. What oil factories are there in your neighborhood and by whom owned ?

44. What is the gross quantity of oil manufactured in a year at each factory ?

45. What is the productive capacity for oil-manufacture of each factory in each year ?

46. What is the description and cost of machinery used in trying-out oil in each factory ?

47. What prices were paid per barrel for fish in 1873 and what in previous years ?

48. What is the average quantity of fish required to produce a gallon of oil ?

49. What quantity of oil can be obtained from one ton of scrap ?

50. What is the least amount of oil per barrel of fish and when is it least ?

51. What is the greatest amount of oil per barrel and when is it greatest ?

52. Do the Northern fish yield more than Southern ?

53. What is the history of the oil-manufacture on this coast ?

54. Where is the principal market for the oil?
55. Where is the principal market for the scrap?
56. What use is made of the oil?
57. What is the range of prices paid for the oil in 1873 and what in previous years?
58. Is it probable that the catch of fish (menhaden), however practiced, tends to diminish them?
59. Name of correspondent.
60. Residence.
61. Date of communication.

APPENDIX B.

LIST OF CORRESPONDENTS FROM WHOM CONTRIBUTIONS HAVE BEEN RECEIVED.

Contributions have been received from the following persons:

- J. Matthew Jones, esq., F. L. S., Halifax, N. S.
 William H. Sargent, collector of customs, Castine, Me.
 Robert A. Friend, oil manufacturer, Brooklin, Me.
 J. C. Condon, oil manufacturer, Belfast, Me.
 Charles G. Atkins, Bucksport, Me.
 Marshall Davis, deputy collector of customs, Belfast, Me.
 John Grant, keeper of Matinicus Rock Light Station, Me.
 Mrs. B. Humphrey, keeper of Manhegin Island Light-House, Me.
 Alden H. Jordan, keeper of Baker's Island Light-House, Me.
 William S. Sartell, keeper of Pemaquid Light Station, Me.
 James A. Hall, collector of customs, Waldoborough, Me.
 Benjamin F. Brightman, Round Pond, Me.
 Luther Maddocks, oil manufacturer, Boothbay, Me., secretary Maine Menhaden Oil and Guano Association.
 G. B. Kenniston, oil manufacturer, Boothbay, Me.
 Thomas Day, keeper of Seguin Light, Parker's Head, Me.
 J. Washburne, jr., collector of customs, Portland, Me.
 Hon. S. L. Goodale, Saco, Me.
 Washington Oliver, keeper of Pond Island Light, Me.
 Chandler Martin, keeper of Whale's Back Light, N. H.
 Judson Tarr & Co., oil manufacturers, Rockport, Mass.
 F. J. Babson, collector of customs, Gloucester, Mass.
 Cyrus Story, Gloucester, Mass.
 Capt. Robert H. Hurlbut, Gloucester, Mass.
 Unknown contributor, Gloucester, Mass.
 Simeon Dodge, collector of customs, Marblehead, Mass.
 Eben B. Phillips, oil dealer, Boston, Mass.
 W. Stowe, American Net and Twine Company, Boston, Mass.

- William Atwood, keeper of Duxbury Pier Light-House, Plymouth, Mass.
 Thomas Loring, collector of customs, Plymouth, Mass.
 Heman S. Dill, keeper of Billingsgate Island Light-House, Wellfleet, Mass.
 David F. Loring, keeper Highland Light-Station, North Truro, Mass.
 Capt. N. E. Atwood, Provincetown, Mass.
 Capt. Josiah Hardy, 2d, keeper of Chatham Light-House, Mass.
 Philip Smith, North Eastham, Mass.
 William S. Allen, keeper, Great Point Light, Nantucket, Mass.
 Reuben C. Kenney, Nantucket, Mass.
 T. C. Defriez, collector of customs, Nantucket, Mass.
 Alonzo F. Lothrop, keeper of Hyannis Light-House, Mass.
 C. B. Marchant, collector of customs, Edgartown, Mass.
 Jason Luce & Co., pound fishermen, North Tisbury, Mass.
 Capt. J. B. Edwards, Light-House Buoy Station, Wood's Holl, Mass.
 E. F. Crowell, Wood's Hole, Mass.
 Capt. Thomas Hinkley, jr., Wood's Holl, Mass.
 Prof. C. A. Goessmann, Amherst, Mass.
 Daniel T. Church, oil manufacturer, Tiverton, R. I.
 Joseph Whaley, keeper of Point Judith Light, R. I.
 E. T. De Blois, Portsmouth, R. I.
 H. O. Ball, New Shoreham, R. I.
 Joshua T. Dodge, Block Island, R. I.
 Henry W. Clark, keeper of South East Light-House, Block Island, R. I.
 Capt. Jared S. Crandall, keeper of Watch Hill Light, R. I.
 Gallup, Morgan & Co., Groton, Conn.
 Capt. John Washington, fisherman, Mystic River, Conn.
 Capt. William H. Potter, fisherman, Mystic River, Conn.
 Luce Brothers, East Lyme, Conn.
 Capt. Leander Wilcox, fisherman, Mystic Bridge, Conn.
 Capt. Samuel G. Beebe, keeper of Cornfield Point Light-Vessel, Saybrook, Conn.
 Richard E. Ingham, keeper of Saybrook Light-House, Conn.
 Prof. J. Hammond Trumbull, Hartford, Conn.
 George W. Burke, M. D., deputy collector of customs, Middletown, Conn.
 Capt. J. L. Stokes, oil manufacturer, Westbrook, Conn.
 George W. Miles, oil manufacturer, Milford, Conn.
 E. H. Jenkins, New Haven, Conn.
 H. L. Dudley, secretary U. S. Menhaden Oil and Guano Association, New Haven, Conn.
 F. Lillingston, Stratford, Conn.
 B. Lillingston, Stratford Point Light-House, Conn.
 W. S. Havens, collector of customs, Sag Harbor, N. Y.
 Capt. Joseph D. Parsons, Springs, N. Y.
 Capt. B. H. Sisson, United States Coast Survey, Greenport, N. Y.
 David F. Vail, oil manufacturer, Riverhead, N. Y.

Hawkins Brothers, oil manufacturers, Jamesport, N. Y.
 Seaman Jones, New York City.
 W. O. Allison, editor Oil, Paint, and Drug Reporter, New York City.
 Jasper Pryer, New York City.
 E. G. Blackford, fish dealer, New York City.
 J. Norrison Raynor, agent for Sterling & Co., Greenport, N. Y.
 Barnet Phillips, New York Times, New York City.
 Louis C. d'Homergue, Brooklyn, N. Y.
 F. F. Beals, secretary American Sardine Company, New York City and Port Monmouth, N. J.
 D. E. Foster, keeper of Cape May Light-House, N. J.
 A. G. Wolf, keeper of Absecom Light-House, Atlantic City, N. J.
 Capt. John D. Sanders, Leedsville, N. J.
 Albert Morris, Somers Point, N. J.
 A. A. Owens, Philadelphia, Pa.
 Joseph B. Benson, Bombay Hook, Del.
 James H. Bell, keeper Mispillion River Light-House, Delaware Bay.
 Benjamin Tice, keeper of Maurice River Light-House.
 Isaac D. Robbins, keeper of Hog Island Light.
 Hance Lawson, collector of customs, Crisfield, Md.
 Dr. H. C. Yarrow, U. S. A., Washington, D. C.
 J. L. Anderton, Apatague Island, Accomac County, Va.
 G. Henry Selden, Kinsale, Westmoreland County, Va.
 Henry Richardson, keeper of Cape Henry Light-House, Va.
 Charles G. Manning, collector of customs, Edenton, N. C.
 A. W. Simpson, jr., assistant keeper Cape Hatteras Light, N. C.
 Wallace R. Jennett, Cape Hatteras, N. C.
 A. C. Davis, collector of customs, Beaufort, N. C.
 William F. Hatsel, keeper of Bodys Island Light-House, N. C.
 Patrick Conner, keeper of Daufuskie Island, S. C., Range Beacons.
 George Gage, collector of customs, Beaufort, S. C.
 W. A. Ham, keeper of Range Beacons Light-House, Morris Island, S. C.
 H. W. Reed, keeper of Tyler Light, Savannah River, Ga.
 J. F. Hall, Brunswick, Ga.
 Joseph Shepard, collector of customs, Saint Mary's, Ga.
 Francis C. Goode, Arlington Bluffs, Saint John's River, Fla.
 Capt. David Kemps, Yellow Bluffs, Saint John's River, Fla.
 Dr. Charles Koch, Jacksonville, Fla.
 Charles Dougherty, New Smyrna, Fla.
 S. H. Wilkinson, keeper of Cat Island Light-House, Miss.
 Silas Stearns, Pensacola, Fla.
 D. P. Kane, keeper Matagorda Light-House, Tex.

The communications of Messrs. F. J. Babson, E. B. Phillips, Josiah Hardy, David T. Church, W. S. Havens, B. H. Sisson, James H. Bell, A. W. Simpson, jr., A. C. Davis, and David Kemps have been particularly valuable as furnishing data concerning habits and migrations;

those of Judson Tarr & Co., J. C. Condon, R. A. Friend, G. B. Kenniston, G. W. Miles, and Hawkins Brothers in the statistics of manufactures; that of Mr. F. J. Babson in the statistics of the bait fisheries, and that of Mr. F. F. Beals in relation to the sardine manufactures. Thanks are due to Melton & Co., of Jacksonville, Fla., for specimens of fish from the Saint John's River.

APPENDIX C.

BIBLIOGRAPHY OF LITERATURE RELATING TO THE MENHADEN.

BREVOORTIA TYRANNUS (Latrobe) Goode.

Clupea tyrannus, LATROBE, Transactions of the American Philosophical Society, vol. v, 1802, p. 77, plate 1 (four figures).

Brevoortia tyrannus, GOODE, Proceedings of the United States National Museum, 1878, p. 5.

Clupea dura levi mystax (Hard Head), BELKNAP, History of New Hampshire, 2d ed., 1813, vol. iii, p. 133. (Name only.)

Clupea menhaden, MITCHILL, Transactions of the Literary and Philosophical Society of New York, vol. i, 1815, p. 453, pl. v, fig. 7.

COOK, Geology of the County of Cape May, State of New Jersey, 1857, p. 113.

GÜNTHER, Catalogue of Fishes in the British Museum, vol. vii, 1868, p. 436.

WHITEAVES, Notes on the Marine Fisheries, and particularly on the Oyster Beds of the Gulf of St. Lawrence, in Sixth Annual Report Department of Marine and Fisheries, 1874, p. 195.

Alosa menhaden, RICHARDSON, Fauna Boreali Americana, 1836, p. 229.

STORER, Report on the Ichthyology and Herpetology of Massachusetts, 1839, p. 117; Memoirs of the American Academy of Arts and Sciences, new series, ii, 1846, p. 459; Synopsis of the Fishes of North America, 1846, p. 207; Mem. Amer. Acad., new series, vi, 1858, p. 386; History of the Fishes of Massachusetts, 1867, p. 158, pl. xxvi, fig. 4, and (?) in Appleton's New American Cyclopaedia.

DEKAY, Zoology of New York, or the New York Fauna, part iv, Fishes, 1842, p. 259, pl. xxi, fig. 60.

AYRES, Enumeration of the Fishes from Brookhaven, Long Island. < Boston Journal of Natural History, vol. iv, 1844, p. 275.

PERLEY, Descriptive Catalogue [in part] of the Fishes of New Brunswick and Nova Scotia in Reports on the Sea and River Fisheries of New Brunswick (2d ed.), 1852, p. 208.

BAIRD, Report to the Secretary of the Smithsonian Institution on Fishes of the New Jersey Coast, as observed in the Summer

of 1854. < Annual Report of the Smithsonian Institution for the year 1854, p. 347, and repaged edition, June, 1855, p. 33; Geology of the County of Cape May, State of New Jersey, 1857, p. 147.

GILL, On the Fishes of New York, in Annual Report of the Smithsonian Institution for the year 1856, p. 266.

COOK, *op. cit.*, l. c.

Alausa menhaden, VALENCIENNES in Cuvier and Valenciennes' *Histoire Naturelle des Poissons*, vol. xx, 1843, p. 424.

Brevoortia menhaden, GILL, Catalogue of the Fishes of the East Coast of North America, 1861, p. 55; Proceedings of the Academy of Natural Sciences, Philadelphia, 1861, p. 37 (diagnosis of genus); Canadian Naturalist, 1867, p. 260, and in Baird's Report on the Sea Fisheries of the South Coast of New England, 1873, p. 826.

STEINDACHNER, in Sixth Annual Report of the Commissioners of Inland Fisheries (Massachusetts), for the year ending January 1, 1872.

BAIRD, List of Fishes collected at Wood's Hole, in Report on the Sea Fishes of the South Coast of New England, 1873, p. 826, and elsewhere in same report, p. 136.

VERRILL, On the Food and Habits of some of our Marine Fishes, in American Naturalist, v, 1871, p. 398; Lists of Species found in the Stomachs of Fishes, in Baird's report *sup. cit.*, 1873, p. 520.

VERRILL, SMITH and HARGER, Catalogue of the Marine Invertebrate Animals of the Southern Coast of New England, and Adjacent Waters, in Baird's report *sup. cit.*, 1873, p. 578 (lernæan parasite).

WHITEAVES, l. c.

BOARDMAN and ATKINS, The Menhaden and Herring Fisheries of Maine, 1875.

GOODE, Catalogue of the Collection to illustrate the Animal Resources of the United States, 1876, p. 63.

UHLER & LUGGER, List of the Fishes of Maryland, in the Report of the Commissioners of Fisheries of Maryland, 1876 (first edition), p. 156; (second edition), p. 133.

HIND, The Effect of the Fishery Clauses of the Treaty of Washington on the Fisheries and Fishermen of British North America, 1877, p. 73.

YARROW, Notes on the Natural History of Fort Macon, N. C., and Vicinity (No. 3), Fishes, in Proceedings of the Academy of Natural Sciences, Philadelphia, 1877, p. 215.

Alosa sadina, MITCHELL, *op. cit.*, p. 457.

DEKAY, *op. cit.*, p. 263, pl. xl, fig. 129.

Alausa shadina, VALENCIENNES, *op. cit.*, p. 426.

Clupea neglecta, RAFINESQUE, Second Decade of New North American Fishes, in American Monthly Magazine, vol. ii, 1818, p. 206.

Clupanodon aureus, SPIX, Selecta Genera et Species Piscium, Brazil, 1829, p. 52, tab. xxi.

Alosa aurea, VALENCIENNES, *op. cit.*, p. 427.

Clupea aurea, GÜNTHER, *op. cit.*, p. 437.

Clupea Carolinensis, GRONOW, Catalogue of Fish collected and described by Lawrence Theodore Gronow, now in the British Museum (ed. GRAY), 1854, p. 40.

"Fish Guano," HALLIDAY, S. B., in Country Gentleman, vol. vi, p. 250. S. W. JOHNSON, *Ibid.* vol. viii, p. 43.

COOK, *op. cit.*

"Menhaden Fisheries and their Products, A new source of Commercial Industry." By LOUIS C. D'HOMERGUE, <in The Manufacturer and Builder, vol. iii, p. 114, May, 1876.

"The Fish Oil and Scrap Business," CONNECTICUT, in American Agriculturist, vol. xxxii, 1873, p. 139.

"Fish Scrap or Guano," EDITORIAL, *ibid.* xxxi, 1872, p. 419.

"The Manufacture of Fish Oil and Guano," ANONYMOUS, *ibid.* xxvi, 1867, p. 400 (with wood cut of menhaden).

"A Fish Oil and Guano Factory," EDITORIAL, *ibid.* xxvii, 1868, p. 451 (with wood cuts of factories and fishing scenes).

"Pound fishing for menhaden."

LYMAN, On the Possible Exhaustion of Sea Fisheries, in Sixth Annual Report of the Commissioners of Inland Fisheries (Mass.), 1872, p. 24.

"The Sardine Industry"—

ANONYMOUS in Harpers Weekly, January, 1875, and Scientific American, February 6, 1875 (with wood cuts of fisheries and process of manufacture).

MENHADEN USED AS FOOD—

ANONYMOUS in Topography and History of Wareham, 1815, in collections of the Mass. Hist. Society, iv, second series, 1816, p. 284.

STORER, I. C., GILL. Fishes of New York.

USE OF RAW FISH FOR MANURE—

FIELD, DAVID D., in Statistical Account of the County of Middlesex, in Connecticut, 1819, p. 153.

THOMPSON, BENJAMIN F., in his History of Long Island, 1839, p. 44.

DWIGHT, TIMOTHY, in his Travels in New England, pp. 305, 513.

BOARDMAN, SAMUEL L. and ATKINS, CHARLES G.

The | Menhaden and Herring Fisheries | of Maine | as sources of fertilization | A Report made to the Maine Board of Agriculture | By Samuel L. Boardman, Secretary of the Board | and | Charles G. Atkins, formerly Fish Commissioner of Maine | 8vo., 1875, pp. 67.

PACIFIC GUANO COMPANY.

The | Pacific Guano Company | its History; its Products and Trade; | its Relation to Agriculture | — | Exhausted Guano Islands of the Pacific Ocean; | Howland's Island, Chincha Islands | etc., etc. | — | The Swan Islands | — | The May Beds and Phosphate Rock of South Carolina | Chisolm's Island Phosphate | The Menhaden | Cambridge: | Printed for the Pacific Guano Company | at | The Riverside Press | 1876 | 8vo., pp. 63.

MADDOCKS, L.

The Menhaden fishery of Maine | with statistical and historical details | its | relations to agriculture | and as a | direct source of human food | — | new processes, products, and discoveries | — | Published by the | Association of the Menhaden Oil and Guano Manufacturers of Maine | Press of B. Thurston & Company, Portland, 1878. Prepared by Mr. Luther Maddocks.

THE MENHADEN AS A BAIT FISH—

Professor Spencer F. Baird, Testimony before the Halifax Commission, 1817, Appendix L, pp. 467, 469.

James Bradley, Testimony, Halifax Commission, 1877, Appendix L, p. 5.

Edward Stapleton, *ib.*, p. 11.

Nathaniel E. Atwood, *ib.*, p. 42.

Benjamin Maddocks, *ib.*, p. 138.

Benjamin Ashby, *ib.*, pp. 246-7.

Robert H. Hulbert, *ib.*, p. 296.

Sylvanus Smith, *ib.*, pp. 334, 341, Appendix M, p. 81.

Major David W. Low, *ib.*, pp. 362, 364, 367, 268.

James H. Myrick, *ib.*, p. 428.

Spencer F. Baird, *ib.*, pp. 457, 458, 460.

William Eaton, Appendix M, p. 6.

L. G. Crane, *ib.*, p. 8.

H. E. Willard, Cape Elizabeth, Me., pp. 10, 11.

Enoch G. Willard, *ib.*, pp. 15, 16.

George Trefethen, *ib.*, pp. 17, 18.

John Conley, *ib.*, p. 21.

O. B. Whitten, *ib.*, p. 23.

S. B. Chase, *ib.*, pp. 25, 26.

M. N. Rich, *ib.*, pp. 27, 28.

Noah Swett, *ib.*, pp. 30, 31.

C. C. Pettingell, *ib.*, pp. 33, 34.

William H. Nelson, *ib.*, pp. 35, 36.

A. W. Small, *ib.*, pp. 38-39.

C. E. Smalley, R. C. Kenney, *ib.*, pp. 40, 41.

Elisha Crowell, *ib.*, pp. 42, 43.

Caleb Nickerson, *ib.*, pp. 45, 46.

Horatio Babson, *ib.*, pp. 48, 49.

- F. W. Friend, *ib.*, pp. 51, 52.
 George W. Plumer, *ib.*, pp. 54, 55.
 H. Knowlton, E. A. Horton, *ib.*, pp. 57, 58.
 Albion K. Pierce, *ib.*, pp. 60, 61.
 George Norwood, *ib.*, pp. 63, 64.
 Andrew Leighton, *ib.*, pp. 66, 67.
 W. C. Wonson, *ib.*, pp. 68, 69.
 George Friend & Co., *ib.*, pp. 71, 72.
 Frederick Gerring, *ib.*, pp. 73, 74.
 F. G. Wonson, *ib.*, pp. 76, 77.
 Charles H. Pew, *ib.*, pp. 78, 79.
 Mauris Whelen, *ib.*, p. 82.
 Thomas Grady, *ib.*, p. 82.
 James G. Tarr, *ib.*, p. 83.
 John E. Gorman, *ib.*, p. 84.
 Henry Hardy, *ib.*, p. 85.
 John E. Saunders, *ib.*, p. 86.
 Richard Hannan, *ib.*, p. 86.
 James G. McKean, *ib.*, p. 195.
 George Crichton, *ib.*, p. 202.
 Christopher Carrigan, *ib.*, p. 202.
 Martin Ryan, *ib.*, p. 204.
 Philip Ryan, *ib.*, p. 204.
 Andrew Laurie, *ib.*, p. 205.
 Thomas England, *ib.*, p. 205.
 Rufus Carrigan, *ib.*, p. 206.
 Charles Lowrie, *ib.*, p. 207.
 George Laidlaw, *ib.*, p. 209.
 Roderick McDonald, *op. cit.*, p. 210.
 Daniel McDonald, *ib.*, p. 211.
 Dougald McKinnon, *ib.*, p. 212.
 James R. McLean, Appendix F, pp. 24, 29.
 Wm. S. McNiell, *ib.*, p. 57.
 George Mackenzie, *ib.*, p. 132.
 James McKay, *ib.*, p. 190.
 John Nicholson, *ib.*, p. 205.
 John Maguire, *ib.*, p. 214.
 James W. Bigelow, *ib.*, p. 222.
 Michael Wrayton, *ib.*, p. 231.
 James Lord, *ib.*, p. 245.
 John F. Taylor, *ib.*, p. 299.
 James A. Tory, *ib.*, p. 323.
 James Hickson, *ib.*, p. 342.
 John McLellan, *ib.*, p. 404.

Knowles, Charles G. F., Third Report of the Department of Marine and Fisheries, 1871, p. 341.

H. W. Johnston, A Special Report on the Distress among the Nova Scotia Fishermen, 1870.

Case of Her Majesty's Government, *op. cit.*, Appendix A, p. 28.

Answer on Behalf of the United States of America to the Case of Her Britannic Majesty's Government, Appendix B, pp. 18, 19.

Reply on Behalf of Her Britannic Majesty's Government to the Answer of the United States of America, Appendix C, pp. 9, 10.

Richard H. Dana, jr., Appendix J, p. 78; Appendix F, p. 67.

APPENDIX D.

EXTRACTS FROM WRITINGS OF ICHTHYOLOGISTS RELATING TO THE MENHADEN.

[From Transactions of the American Philosophical Society, Vol. V, 1802, pp. 77-81.]

A DRAWING AND DESCRIPTION OF THE *CLUPEA TYRANNUS* AND *ONISCUS PRÆGUSTATOR*. BY BENJAMIN HENRY LATROBE, F. A. P. S.

The committee, to whom was referred Mr. Latrobe's paper on a species of *Oniscus*, called by the author *Oniscus prægustator*, reports that the same is worthy of publication.

BENJAMIN SMITH BARTON.

FEBRUARY 17, 1800.

PHILADELPHIA, *December 18th*, 1799.

TO THOMAS P. SMITH,

One of the Secretaries of the American Philosophical Society :

SIR : I beg leave, through your means, to communicate to the American Philosophical Society an account of an insect, whose mode of habitation, at least during some part of his life, has appeared to me one of the most singular, not to say whimsical, that can be conceived.

In the month of March, 1797, illness confined me, for several days, at the house of a friend on York River, in Virginia, during his absence. My inability to move farther than the shore of the river gave me leisure to examine carefully, and in more than an hundred instances, the fact I am going to mention.

Among the fish that, at this early season of the year, resort to the waters of the York River, the alewife, or old-wife, called the bay-alewife (*Clupea nondescripta*), arrives in very considerable shoals, and in some seasons their number is almost incredible. They are fully of the size of a large herring, and are principally distinguished from the herring by a bay or red spot above gill-fin. They are, when caught, from March to May, full-roed and fat, and are at least as good a fish for the table as the herring. In this season, each of the alewives carries in her mouth an insect, about two inches long, hanging with its back downwards and firmly holding itself by its 14 legs to the palate. The fishermen call this insect "the louse." It is with difficulty that it can be separated, and

perhaps never without injury to the jaws of the fish. The fishermen, therefore, consider the insect as essential to the life of the fish, for when it is taken out, and the fish is thrown again into the water, he is incapable of swimming and soon dies. I endeavored in numerous instances to preserve both the insect and the fish from injury, but was always obliged either to destroy the one or to injure the other. I have sometimes succeeded in taking out the insect in a brisk and lively state. As soon as he was set free from my grasp, he immediately scrambled nimbly back into the mouth of the fish and resumed his position. In every instance he was disgustingly corpulent and unpleasant to handle, and it seemed, whether he have obtained his post by force or by favor, whether he be a mere traveler or a constant resident, or what else may be his business where he is found, he certainly has a fat place of it, and fares sumptuously every day.

The drawings annexed to this account were made from the live insect, and from the fish out of whose mouth he was taken. I had no books to refer to then; but examining the *Systema Naturæ* of Linnæus, I was surprised to find so exact a description of the insect as follows (see *Salvii Editio*, Holmiæ, 1763, 1060, also Trattner's Vienna edition, same page):

“Insect, apt. *Oniscus*, *Pedes* XIV.

Antennæ setaceæ.

Corpus ovale.

“*O. physodes*, abdomine subtus nudo caudâ, ovatâ; habitat in pelago; corpus præter caput, et caudam ultimum, ex septem segmentis trunci, et quinque caudæ. *Antennæ* utrinque duo, breves. *Caudæ* folium terminale omino ovatum; ad latera utrinque subtus auctum duobus peteolis diphyllis, foliolis lanceolatis, obtusis, caudâ brevioribus. *Caudæ* articuli subtus obtekti numerosis vesiculis longitudine caudæ.”

From the particularity with which the *Oniscus physodes* is described by Linnæus, it is evident that he had the insect before him, or a description by an attentive observer. It appears also from the “habitat in pelago,” that the *O. physodes*, if this be the insect, is found detached from his conductor. There are a few points in which the *O. physodes* differs from my insect. I did not observe the antennæ, perhaps for want of sufficient attention, or of a microscope. The peteoli of the tail were not, to appearance, two-leaved, and I am certain that the segments of the tail, and the tail itself, were without the vesiculi longitudine caudæ.

There are many circumstances, to ascertain which is essential to the natural history of this insect. The fish whose mouth he inhabits comes, about the same time with the shad, into the rivers of Virginia from the ocean, and continues to travel upward from the beginning of March to the middle of May; as long as they are caught upon their passage up the river, they are found fat and full of roe. Every fish which I saw had the *Oniscus* in his mouth, and I was assured, not only by the more ignorant fishermen, but by a very intelligent man who came down now

and then to divert himself with fishing, that, in forty years' observation, he had never seen a bay-alewife without the louse. The shad begin to return from the fresh water lean and shotten about the end of May and beginning of June, and continue descending during the remaining summer months. No one attempts then to catch them, for they are unfit for the table. Whether the bay-alewife returns with the shad, I could not learn, but it is certain that after June it is not thought worth the trouble to catch them. No one could tell me positively whether the *Oniscus* still continues with them, but it was the opinion of my informant, that, like every other parasite, he deserts his protector in his reduced state, for he could not recollect that he had ever seen him in the mouth of those accidentally caught in the seine in July or August.

I consider, therefore, the natural history of the *Oniscus* which I now communicate as very imperfect; and it were to be wished that some lover of natural science would follow up the inquiry, by endeavoring to ascertain whether he continue with, or quit the fish before his return to the ocean, and also whether he be the *Oniscus physodes* of Linnæus, qui habitat in pelago.

Should he be an insect hitherto undescribed, I think he might be very aptly named, *Oniscus prægustator*.

The bay-alewife is not accurately described in any ichthyological work which I have seen; nor can I from my drawings, which were made with a very weak hand, venture a description. From his having a regular prægustator, I would suggest that he ought to be named *Clupea tyrannus*.

The *Oniscus* resembles the minion of a tyrant in other respects, for he is not without those who suck him. Many of those which I caught had two or three leeches on their bodies, adhering so closely that their removal cost them their heads. Most of the marine *Onisci* appear to be troublesome to some one or other fish. The *Oniscus ceti* is well known as the plague of whales, and many of the rest are mentioned in Linnæus and Gmelin as pestes piscium.

BENJA. HENRY LATROBE, F. A. P. S.

P. S.—A gentleman well skilled in entomology informs me that he believes that in Block's History of Fishes, a work not to be had in Philadelphia, this *Oniscus* is mentioned. But, from a late examination of Gmelin and Fabricius, I am convinced that the *Oniscus prægustator* is a species not hitherto accurately described. Gmelin had probably seen the Linnæan insect, having changed the antennae utrinque duo to antennis quaternis, and left out most of the long description given by Linnæus. Neither he, Linnæus, nor Fabricius mentions the circumstance of habitation in the mouth of the fish, and the industrious and copious Fabricius, who having changed the names of the genera, calls him *Cymothoa physodes*, copies the description of Gmelin, excepting the mention of the 4 antennae, which in his arrangement form a character of the genus.

[From "The Fishes of New York, described and arranged," by Samuel L. Mitchill, in Transactions of the Literary and Philosophical Society of New York, 1815, p. 453.]

BONY-FISH, HARD-HEADS, OR MARSHBANKERS, OF NEW YORK.
(*Clupea menhaden*.)

About fourteen inches long, frequent the New York waters in prodigious numbers. From the high banks of Montock, I have seen acres of them purpling the water of the Atlantic Ocean. The waters of Long Island Sound and its bay are often alive with shoals of them. They are eatable; but as they are too abundant for consumption as food, and as there are multitudes of preferable fish, menhaden are often left to putrefy on the shore or are removed to the fields for manure.

The history of this fish has been written by Mr. B. H. Latrobe, and published with a figure, in the Philosophical Transactions of Philadelphia, Vol. v. And the manner of converting him to an ingredient for fertilizing land has been explained by Ezra L'Hommedieu, esq., in the Agricultural Transactions of New York, Vol. I., p. 65. The aborigines called him menhaden. The whalemén say he is the favorite food of the great bone-whale or *Balæna mysticetus*. This creature, opening its mouth amidst a shoal of menhaden, receives into its cavity the amount of some hogsheads of menhaden at a gulp. These pass, one by one, head foremost down his narrow gullet; and eye-witnesses have assured me that on cutting up whales after death, great quantities of menhaden had been discovered thus regularly disposed in the stomach and intestines.

Gill-cover very large. One blackish spot on the neck near it. Head and back greenish-brown, with a few marks of brighter green on the head. Belly and sides considerably iridescent. Back arched, rounded, and thick; tail forked; belly serrated; mouth and tongue toothless and smooth; gills rising from the back of the tongue on both sides of the wide throat.

Rays, Br. 7, P. 15, V. 7, D. 19, A. 19, C. 27.

[From "The Fishes of New York described and arranged," by Samuel L. Mitchill, in Transactions of the Literary and Philosophical Society of New York, 1815, p. 457.]

NEW YORK SHADINE (*Clupea sadina*).

An elegant species, with a small smutty spot behind the gill-cover, but with neither spots nor stripes on its back or sides; mouth wide and toothless; tongue small; back delicately variegated with green and blue; lateral line straight; sides silvery white, considerably above that line, and below it quite to the belly; the white reflects vividly green, red, and other splendid hues; head rather elongated; lower jaw projecting; scales very easily deciduous; form neat, taper, and slender; gills rise into the throat on each side of the root of the tongue; eyes pale and large; tail deeply forked; on account of the even connection of the false ribs, the belly is not at all serrated, but quite smooth; a semi-transparent space in front of the eyes from side to side.

Rays, Br. 7, P. 16, V. 9, D. 18, A. 15, C. 19.

[From Storer's "History of the Fishes of Massachusetts," 1867, p. 158.]

ALOSA MENHADEN, Storer. The Menhaden.

(Plate XXVI, Fig. 4.)

Clupca menhaden, Bony-fish, Hard-heads, or Marsh-bankers of New York, MITCH., Trans.

Lit. and Phil. Soc. of New York, 1, p. 453, pl. 5, fig. 7.

Alosa menhaden, Menhaden, Hard-head, STORER, Report, p. 117.

Alosa menhaden, Moss-bonker, DEKAY, Report, p. 259, pl. 21, fig. 60.

Alosa menhaden, AYERS, Bost. Jour. Nat. Hist., iv, p. 275; STORER, Mem. Amer. Acad., new series, 11, p. 459.

Alosa menhaden, STORER, Synopsis, p. 207.

L'Alose menhaden, CUV. & VAL., Hist. Nat. des Pois., xx, p. 424.

Color.—Upper part of body of a greenish-brown, darker upon the top of the head and at the snout; upper part of the sides in the living fish roseous and mottled with indistinct bluish oscillations, which disappear in death; abdomen silvery; gill-covers cupreous, with a rosy tint; space in front of the eyes translucent; a black spot, more or less distinct, upon the shoulders; whole surface of the fish iridescent.

Description.—Body elongated, compressed; its depth across, at the base of the pectorals, less than one-fifth the length of the fish; length of the head more than one-third the length of the fish; gill-covers very large; opercula, with numerous deeply marked striæ, which commence just beneath a large green blotch, situated some distance back of the eye and on a line with it, and pass obliquely backward and downward to its lower edge; subopercula and interopercula smooth; preopercula presenting an arborescent appearance of vessels upon their surface; eyes circular, moderate in size, furnished with a nictitating membrane; gape of mouth very large; lower jaw shorter than the upper; the middle of the upper jaw deeply emarginate; back slightly arched in front of the dorsal fin.

The dorsal fin commences upon the anterior half of the body; it is nearly as long again as high, and is emarginated above; at its base is a membranous prolongation or sheath, by which it is almost entirely covered when unexpanded. The first three rays of this fin are simple; the first articulated rays are higher than the remainder, the most posterior higher than the eight or nine preceding.

The pectorals are situated just beneath the posterior inferior angle of the operculum; the first three rays are the longest; the first ray is simple. Outside of this fin is an axillary plate more than two-thirds the length of the fin; a broad scaly shield at the base of the pectorals covers a portion of the inferior edge.

The ventrals are very small and fan-shaped, their rays are multifid; on each side of these fins is an axillary plate.

The anal fin is shorter than the dorsal, low and slightly emarginated above; its anterior rays are highest; the first ray is simple; it is sheathed at its base like the dorsal.

The caudal fin is deeply forked; the depth of the fin at its extremities, when expanded, is equal to the height of the outer rays.

The fin rays are as follows: D. 19; P. 15, 16, or 17; V. 6; A. 20, 21, or 22; C. 20 $\frac{1}{4}$.

Length, eight to fourteen inches.

[From Dekay's "Zoology of New York," Part IV., Fishes, 1842, p. 259.]

THE MOSSBONKER. *Alosa menhaden*.

(Plate XXI, Fig. 60.)

Bony-fish or Mossbonker. *Clupea menhaden*.

MITCHILL, Report in part, &c., p. 21.

Hard-head or Marsbankers. *C. menhaden*.

Id. Trans. Lit. and Phil. Soc., vol. 1, p. 453.

The Menhaden, Hard-head. *Alosa menhaden*.

STORER, Massachusetts, Report, p. 117.

Characteristics.—Silvery; no stripes; a humeral spot. A double accessory ray to the ventrals. Abdomen serrated behind the ventrals. Length 10–14 inches.

Description.—Body much compressed; its height to its length as one to four nearly. Abdomen cultrate, with a fissure along its edge, indistinctly serrated before the ventrals, sharply serrate behind. Scales large, elliptical, distinctly and evenly ciliate on the free margins; on the back smaller and more crowded; on the nape the scales have longer unequal ciliæ. No appearance of a lateral line. Head large, compressed, one-third of the total length; the opercles with curved and radiating striæ. Mouth large, the upper jaw emarginate on the side. The gill membrane on one side folds over its opposite, with five slender cylindrical, and three larger and flat rays. Branchial arches four, with a small rudimentary one in front, all angular, and with a long minutely fringed filament. Eyes nearly covered by a nictitating membrane. Tongue soft, white, minutely punctate with black. The dorsal fin long, emarginate; the first three rays simple, articulated; the anterior being very short, the remainder branched; first branchial ray highest, the last higher than the four preceding. This fin is concave on its margin, and is placed in a sheath. Pectorals long and pointed on a line with the margin of the opercles; the first ray simple; the accessory plate large and as long as the fifth ray. Ventrals feeble, short, fan-shaped, lying under the anterior portion of the dorsal, with double accessory plates. Anal long and low, the two first rays simple, the first shortest; the last ray longer than the fourteen preceding. Scales covering the base of the rays, so as to form a sort of sheath. Caudal forked, much branched, and with numerous accessory rays. Scales extending high

up on the fin, and very minute ones distributed ulmost to the tip. Abdomen covered internally with a black pigment. Intestines long and convoluted; cæca numerous, attached to a stout muscular stomach, lined with a white rugose membrane, covered with numerous papillæ. Air-bladder simple.

Color.—Summit of the head and back greenish; silvery on the sides. In the plates, more of a yellow hue is given to this fish than belongs to him. A dark brown spot on the shoulders, behind the opercles. Irides yellow. A space anterior to the eyes so translucent as to permit opaque objects to be seen through on the other side.

Length 8.0–14.0.

Fin-rays, D. 20; P. 16; V. 6; A. 22; C. 20 $\frac{1}{4}$.

This fish is known under the various names of bony-fish, hard-head, mossbonkers (or, as it is pronounced by our Dutch inhabitants, morse-bonkers), panhagen, and menhaden; the last being the name given by the Manhattans, and panhagen (pronounced panhangen) the Narragansett epithet. At the east end of the island, they are called skippangs, or bunkers. Although seldom eaten, as it is dry, without flavor, and full of bones, yet it is one of the most valuable fish found within our waters. Its use as a manure is well known in the counties of Suffolk, Kings, and Queens, where it is a source of great wealth to the farmer who lives upon the sea-coast. They are used in various ways: for Indian corn, two or three are thrown on a hill; for wheat, they are thrown broadcast on the field, and plowed under; although it is not uncommon to put them in layers alternately with common mold, and when decomposed spread it like any other compost. Its effects in renovating old grass-fields, when spread over with these fish at the rate of about two thousand to the acre, are very remarkable. Its value, however, as a manure has one drawback in the abominable and unhealthy stench which poisons the whole country, and, according to the testimony of some medical writers, lays the foundation of dysenteries and autumnal fevers. They appear on the shores of Long Island about the beginning of June, in immense schools; and as they frequently swim with a part of the head above or near the surface of the water, they are readily seen and captured. They are commonly sold on the spot at the rate of \$2 the wagon-load, containing about a thousand fish. The largest haul I remember to have heard of was through the surf at Bridgehampton, at the east end of the island. Eighty-four wagon loads, or, in other words, 84,000 of these fish were taken at a single haul. On the coast of Massachusetts they are used as bait for mackerel, cod, and halibut; and many are packed away for exportation to the West Indies. According to Dr. Storer, in 1836, 1,488 barrels were thus salted down for exportation. I am not aware that its geographical limits pass beyond the coast of New Hampshire on one side, and Chesapeake Bay on the other.

[From Cuvier and Valenciennes' "Histoire Naturelle des Poissons," vol. xx, p. 424.]

L'ALOSE MENHADEN. (*Alausa menhaden*, nob.)

Cette clupée, très abondante aux Etats-Unis, l'un des produits considérables des vastes fleuves de cette contrée, est éminemment remarquable par la grosseur de sa tête et par la hauteur de la région pectorale du tronc; elle égale trois fois et demie la hauteur de la queue. La longueur de la tête surpasse en quelque peu cette hauteur, et elle est comprise trois fois dans la distance entre le bout du museau et la naissance de la caudale. Ces proportions montrent que le corps est extrêmement trapu. La mâchoire supérieure ne dépasse pas l'inférieure. L'oeil est recouvert d'une double paupière adipeuse très-épaisse. L'opercule a de fines stries et de jolies très agréablement ramifiées. De fines stries rayonnantes couvrent l'opercule; il y en a aussi vers le bas du préopercule. Le sous-opercule et l'interopercule sont très grands. La ceinture humérale est étroite. La dorsale est sur le milieu de la longueur du tronc. Les nombres des rayons de ces nageoires ne diffèrent pas de ceux des autres espèces.

D. 19; A. 19; C. 27; P. 15; V. 7.

Les écailles sont finement et longuement ciliées. Leur portion libre est petite; la partie radicale a des stries verticales et parallèles au bord. De chaque côté du dos on remarque deux rangées d'écailles beaucoup plus profondément ciliées, et que, en s'enchevêtrant sur la ligne moyenne, forment une singulière gouttière le long de cette ligne. Des écailles membraneuses font une gouttière assez profonde, dans laquelle s'engage la dorsale. Une tache d'un bleu foncé existe sur le haut de l'épaule, et se conserve parfaitement sur les individus gardés depuis longtemps dans l'alcool. Le dos est verdâtre; tout le reste du poisson brille d'un vif éclat argenté. Nous avons reçu de nombreux individus de cette espèce. Les plus grands n'ont que treize à quatorze pouces. M. M. Milbert et Lesueur les ont envoyés en abondance des marchés de New York et de Philadelphie. M. Bosc avait rapporté l'espèce de la Caroline, et récemment M. Holbroock m'en a envoyé d'autres exemplaires des marchés de Charlestown. Enfin, M. le comte de Castelman en a convoyé de l'embouchure de l'Hudson.

L'espèce a paru pour la première fois dans le mémoire de M. Mitchill sous le nom que nous lui conservons. Nous la retrouvons dans les ouvrages de MM. Storer et Dekay. Celui-ci en a donné une belle figure, et le premier de ces auteurs a fait connaître le nombre considérable de barils que l'on exporte chaque année. Comme c'est un poisson très-huileux, on s'en sert plutôt comme engrais ou comme amorce, surtout pour les grands Flétans (*Peuronectes hippoglossus*). C'est sous ce rapport qu'il devient l'objet d'un commerce considérable. Au nom de Menhaden, qui est une de ses dénominations vulgaires, il faut ajouter celle de *Panhagen* et de *Mossbonkers* ou de *Bonyfish*, etc.

[From Uhler & Lugger's List of the Fishes of Maryland, 1876, p. 133.]

BREVOORTIA MENHADEN. Ale-wife, or Menhaden.

Body elongated, compressed. Its depth across, at the base of the pectorals, less than one-fifth the length of the fish; length of the head more than one-third the length of it. Gill-covers very large. Upper part of body greenish-brown, darker upon the top of the head and at the snout; upper part of the sides in the living fish rose-colored and mottled with blue, which disappear in death; abdomen silvery; a black spot, more or less distinct, upon the shoulders; whole surface of the fish iridescent.

Length 10 to 14 inches.

Fin-rays: D. 19; P. 15-17; V. 6; A. 18-22; C. 20.

B. menhaden, MITCH., Lit. and Phil. Trans. New York, i. p. 453, pl. 5, fig. 7.

Alosa menhaden, Storer, Report Fish. Massach., p. 117; DEKAY, York Faun., Fish., p. 259, pl. 21, fig. 60; AYERS, Boston Jour. Nat. Hist., iv, p. 275; STORER, Mem.

Am. Ac., vi. p. 337, pl. 26, fig. 3.

Brevoortia menhaden, GILL., Proc. Ac. Nat. Sc. Philad., 1861, p. 37.

Common on the Atlantic coast of Worcester County and even entering Sinepuxent Bay, also in vast shoals in Chesapeake Bay, particularly about the mouths of the great rivers of both peninsulas. They have been extensively used for manure by the farmers living near the coast, where they are caught by untold thousands in the large seines.

Acad. Coll. S. I.

[From Perley's Reports on the Sea and River Fisheries of New Brunswick, 1852, p. 208.]

SPECIES 3.—*Alosa menhaden*—THE MOSSBONKER.

This fish is known by a variety of popular names, among which are "bony-fish," "hard-head," "pauhagen," and "menhaden." It is seldom eaten, being dry, without flavor, and full of bones. On the coast of the United States it is used as bait for cod, and also extensively as manure for renovating old grass-fields, but not without injury to the health of those who reside in the vicinity. The mossbonker is sometimes caught in the weirs, within the harbor of Saint John, in considerable numbers; it has occasionally been sold to the ignorant for fall shad, to which it bears some resemblance. The mossbonker is exclusively a sea-fish, never entering the fresh water.

[From Gray's "Catalogue of Fish, collected and described by Lawrence Theodore Gronow, now in the British Museum," 1854, p. 140.]

CLUPEA CAROLINENSIS—M. G. B. M.

Clupea immaculata argentea abdomine anteriore prominulo dentato: lateribus amplissimis.

Habitat gregatim ad Carolinam Meridionalem.

Longitudo tota quinque pollicaris et altitudo maxima paulo ante pinnam dorsalem est unius pollicis deinde.

Dorsum rectum, convexum, capitiparrellelum. *Caput* cathetoplateum, cranium rectum convexiusculum; utringue compressum subtus angustatum carinatum adscendens a juncturis branchiarum versus os. *Oculi* magni, ori proximi: mystaces lalissimæ oseæ pellucidæ inermes *Maxilla inferior* angusta, acuminata, oblique sursum spectans, ad superiorem adductilis. *Opercula* planiuscula, latissima, splendens rotundatetruncata. *Latera* planiuscula, obliquata, mox post pinnas pectorales latissima, versus caudam gracilescentia. *Abdomen* carinatum valde prominens, squamis denticulato-serratum. *Color* argenteus splendens, in dorso cœrulescens. *Linea lateralis* nulla. *Squamæ* imbricatim sitæ, latæ, deciduæ. *Prima Dorsi* in medio dorso parva radiis 18. *Pectorales* in imo pectore radiis 17. *Ventrales* approximatae parvæ in imo ventre, initio dorsalis oppositæ medio inter ventrales et analem, radiis sex. *Anal* humilis, medio inter ventrales et caudam, radiis 18, sensim decrescentibus. *Cauda* profunde bifurcata, lobis æqualibus acuminatis, radiis contiguis, subramosis. Latitudine laterum præsertim ab *Harengo B* differre videtur.

[From Günther's "Catalogue of the Fishes in the British Museum," vol. vii, p. 436.]

CLUPEA MENHADEN. Mossbanker.

Clupea menhaden, MITCH., *Lit. & Phil. Trans.*, New York, i, p. 453, pl. 5, fig. 7.

Atosa menhaden, STORER, *Report Fish. Massach.*, p. 117; DEKAY, *N. York Faun.*, p. 259, pl. 21, fig. 60; AYERS, *Bost. Journ. Nat. Hist.*, iv, p. 275; CUV. & VAL., xx, p. 424; STORER, *Mem. Am. Ac.*, vi, p. 337, pl. 26, fig. 3.

— *sadina*, DEKAY, l. c., p. 263, pl. 40, fig. 129. MITCHILL'S *Clupea sadina* (*Trans. Lit. & Phil. Soc. New York*, i, p. 457) was evidently a different fish, which, however cannot be determined at present.

Clupea carolinensis, GRONOV, *Syst.*, ed. Gray, p. 140.

Brevoortia menhaden, GILL, *Proc. Ac. Nat. Sc. Philad.*, 1861, p. 37. (Name only.)

D 19; A. 19-20; V. 7.

Scales irregularly arranged; their free portion is very narrow and deep, with the margin ciliated. *The height of the body is rather less than the length of the head, which is one-third of the total (without caudal).* Lower jaw shutting within the upper; maxillary reaching to the vertical from the hind margin of the orbit. No teeth on the palate or tongue. Operculum finely striated; suboperculum large, tapering above. Gill-rakers very fine and exceedingly long; the horizontal branch of the outer branchial arch consists of two portions joined at an obtuse angle. Ventral fins opposite to the anterior third of the dorsal, the origin of which is somewhat nearer to the caudal than to the end of the snout. Basil half of the caudal fin covered with small scales. There are from twelve to thirteen abdominal scutes behind the base of the ventral fins. A blackish blotch in the scapular region.

Atlantic coast of the United States.

a, b, Adult New York. Purchased of Mr. Brandt. *c, d*, Half-grown and young; skins; New York. From Mr. Parnell's collection. *e, f*, Young, North America. Presented by E. Doubleday, esq. *g*, Young. Old collection (*Clupea smaragdina*). *h*, Young; skin. From Gronow's collection. Type of *Clupea carolinensis*.

APPENDIX E.

CATALOGUE OF SPECIMENS IN THE NATIONAL MUSEUM.

Catalogue number.	Sex and age.	Locality.	When collected.	Collected by—	Nature of specimen.	Remarks.
16369	Young..	Wood's Holl, Mass.		United States Fish Commission.	Alcoholic	
12831	..do ..	Washington, D. C.		Captain Evans.	..do ..	
13369	..do ..	Wood's Holl, Mass.		United States Fish Commission.	..do ..	
13356	..do ..	..do ..		..do ..	..do ..	
15055	..do ..	..do ..		..do ..	..do ..	
13370	..do ..	Wood's Holl, Mass.		United States Fish Commission.	..do ..	
13371	..do ..	..do ..		..do ..	..do ..	
13372	..do ..	..do ..		..do ..	..do ..	
13365	..do ..	..do ..		..do ..	..do ..	
19146	..do ..	..do ..		Vinal N. Edwards.	..do ..	
16378	..do ..	Robinson's Holl, Mass.		United States Fish Commission.	..do ..	
13368	..do ..	Wood's Holl, Mass.		..do ..	..do ..	
13359	..do ..	..do ..		..do ..	..do ..	
20013	..do ..	..do ..		Vinal N. Edwards.	..do ..	
5055	..do ..	..do ..		S. F. Baird	..do ..	
13373	..do ..	..do ..		United States Fish Commission.	..do ..	
13363	..do ..	..do ..		..do ..	..do ..	
20630	..do ..	..do ..		Vinal N. Edwards.	..do ..	
16386	..do ..	..do ..		United States Fish Commission.	..do ..	
13357	..do ..	..do ..		..do ..	..do ..	
14133	..do ..	Noank, Conn.		..do ..	..do ..	
13362	..do ..	Wood's Holl, Mass.		..do ..	..do ..	
16368	..do ..	..do ..		..do ..	..do ..	
13360	..do ..	..do ..		..do ..	..do ..	
20616	..do ..	..do ..		Vinal N. Edwards.	..do ..	
14136	..do ..	Noank, Conn.		United States Fish Commission.	..do ..	
13361	..do ..	Wood's Holl, Mass.		..do ..	..do ..	
15218	..do ..	Noank, Conn.		..do ..	Stomach	
13374	..do ..	Wood's Holl, Mass.		..do ..	Alcoholic	
13375	..do ..	Menemsha Bight, Mass.		..do ..	..do ..	
14917	..do ..	Wood's Holl, Mass.		..do ..	..do ..	
14139	..do ..	..do ..		..do ..	Ovaries	
13364	..do ..	..do ..		..do ..	Alcoholic	
20,89	..do ..	..do ..		Vinal N. Edwards.	..do ..	
13367	..do ..	..do ..		United States Fish Commission.	..do ..	
13358	..do ..	..do ..		..do ..	..do ..	
20679	..do ..	..do ..		Vinal N. Edwards.	..do ..	
20666	..do ..	..do ..		..do ..	..do ..	
10405	Ad ..	..do ..		S. F. Baird	..do ..	709 C. A. S.
5152	Young..	West Florida		Kaiser and Martin.	..do ..	
892	..do ..	Brazos Santiago, Tex.		Capt. Van Vliet	..do ..	
5364	..do ..	..do ..		New Orleans Academy.	..do ..	
801	..do ..	Mouth Rio Grande		Emery & Clark	..do ..	
7696	..do ..	Indian River		Wurdeemann	..do ..	
5048	..do ..	Mississippi		B. L. C. Walls	..do ..	
15217	..do ..	Noank, Conn.	Aug. 24, 1874	United States Fish Commission.	Ovaries	
16947	..do ..	Maine	Aug. 20, 1876	S. L. Goodale	..do ..	
16946	..do ..	..do ..	Sept. 14, 1876	..do ..	..do ..	

Catalogue of specimens in the National Museum—Continued.

Catalogue number.	Sex and age.	Locality.	When collected.	Collected by—	Nature of specimen.	Remarks.
896	Fort Brown, Tex.	—, 1858	Major Emory	Alcoholic	Ovaries.
13355	Wood's Holl, Mass.	Sept. 26, 1874	United States Fish Commission.	do	
13366	do	Sept. 4, 1874	do	do	
14044	Noank, Conn.	—, 1874	do	do	
14138	do	July 29, 1874	do	do	
14345	do	—, 1874	do	do	
14446	do	do	do	do	
16013	Wood's Holl, Mass.	July 2, 1875	do	do	
16015	do	do	do	do	
16014	do	do	do	do	
16033	Buzzard's Bay	—, 1875	do	do	Ovaries, &c. Color sketch.
16198	Wood's Holl, Mass.	June 10, 1875	do	do	
16313	do	Aug. 4, 1875	do	do	
16363	do	Aug. 5, 1875	do	do	
16367	do	do	do	do	
16463	Menemsha Bight, Mass.	Aug. 3, 1875	do	do	
16596	do	Sept. 5, 1875	do	do	Cast No. 567.
16796	do	—, 1876	do	do	
17927	Saint John's River, Fla.	Apr. 2, 1877	S. F. Baird	do	
18049	do	do	do	do	
19042	Florida	—, 1875	G. Brown Goode	do	
19043	do	do	do	do	
19044	do	do	do	do	
19045	do	do	do	do	
19046	do	do	do	do	
19137	Wood's Holl, Mass.	—, 1876	Vinal N. Edwards.	do	
19359	do	—, 1875	United States Fish Commission.	do	
19360	do	do	do	do	
19361	do	do	do	do	
19362	do	do	do	do	
19363	do	do	do	do	
19364	do	do	do	do	
19457	Potomac River.	May —, 1875	Milner and Goode	do	
19468	Eastern Shore of Virginia.	—, 1875	Prof. H. E. Webster	do	
19632	Beaufort, N. C.	—, 1872	Dr. H. C. Yarrow	do	
19918	do	do	do	do	
20016	Wood's Holl, Mass.	—, 1876	Vinal N. Edwards.	do	Cast
20257	do	do	do	do	
20516	Menemsha Bight, Mass.	—, 1875	United States Fish Commission.	do	
20603	Wood's Holl, Mass.	Oct. 2, 1877	do	do	
20857	do	Nov. 24, 1877	do	do	
10696	Wood's Holl, Mass.	do	United States Fish Commission.	do	
16313	do	Aug. 1, 1875	do	do	
16796	do	1876	do	do	

Photographs.—257, 258, 259, 260, 386, 387.—UNITED STATES FISH COMMISSION.

APPENDIX F.

TABLES SHOWING MONTHLY MEANS OF TEMPERATURE FOR CERTAIN POINTS ON THE ATLANTIC COAST OF THE UNITED STATES FOR THE YEAR INCLUDED BETWEEN MARCH 1, 1876, AND MARCH 1, 1877.

TABLE I.—*Table of surface temperatures, March, 1876, to February, 1877, inclusive, at 3 p. m.*

Place of observation.	Spring.			Summer.			Autumn.			Winter.			Year ending February, 1877.				
	March, 1876.	April, 1876.	May, 1876.	Quarter ending May, 1876.	June, 1876.	July, 1876.	August, 1876.	Quarter ending August, 1876.	September, 1876.	October, 1876.	November, 1876.	Quarter ending November, 1876.		December, 1876.	January, 1877.	February, 1877.	Quarter ending February, 1877.
Eastport, Me.....	32.5	35.3	38.4	35.4	42.7	47.2	50.2	46.7	50.6	50.6	(46.1)	(48.9)	40.1	31.5	29.8	33.8	41.0
Portland, Me.....	33.9	(38.1)	(47.3)	(39.7)	56.9	66.7	63.9	62.5	57.1	50.3	44.9	50.7	34.5	30.6	33.9	33	46.4
Wood's Holl, Mass.....	31.3	43.2	52.3	43.2	67.4	75.1	72.4	71.6	65.5	56.4	48	(52.2)	34.3	29.9	31.4	31.8	49.5
New London, Conn.....	38	46.1	56.8	46.9	69.2	73	73.3	71.8	65.5	57.2	49.7	57.7	38.2	33.8	36.2	36	52.6
New York, N. Y.....	33.5	39.6	51	41.3	63.1	72.2	72.5	70.9	64.5	53	47	54.8	(32.3)	28.2	32.4	(30.9)	49.4
Baltimore, Md.....	42	51.5	64.5	52.6	77.1	84.1	78.3	73.8	70.7	58	50.8	59.8	35	32.2	32.2	(33.6)	56.4
Norfolk, Va.....	48.8	57.6	67.9	58	79.6	84.4	78.1	80.7	(69.2)	60.5	53.8	(61.1)	36.8	38.6	44	39.8	59.9
Kitty Hawk, N. C.....					(72.7)	73.1	72.5	(74.8)	72.4								
Wilmington, N. C.....	55.3	61.9	71.7	62.9	75.3	81.3	80.3	78.9	77.3	64.1	58.2	66.5	44.5	41.9	50.1	45.5	63.4
Charleston, S. C.....	59.1	64.3	72.8	67.4	79.4	87.3	(85.6)	83.4	81.1	64.5	60.8	68.8	46.6	48.3	52.2	49	68.6
Savannah, Ga.....	56.5	60.5	67.2	61.4	72	(77.6)	83	77.5	81.3	72.6	(53.6)	(67.4)	44.4	48.9	51.7	48	63.8
Jacksonville, Fla.....	(64.8)	73.1	80.9	(72.9)	85.2	88.3	88.2	87.2	86.1			(75.3)	(51.2)	56.6	58.9	(55.5)	72.7
Key West, Fla.....	75.4	78.5	83.1	79	86.6	86.4	86.4	86.4	87.7	81.5	74.2	81.1	66.4	73.1	69.3	69.6	79

TABLE III.—Table of mean temperatures of surface and bottom, March, 1876, to February, 1877, inclusive.

Place of observation.	Spring.				Summer.				Autumn.				Winter.				Year ending February 28, 1877.
	March, 1876.	April, 1876.	May, 1876.	Quarter ending May 31, 1876.	June, 1876.	July, 1876.	August, 1876.	Quarter ending August 31, 1876.	September, 1876.	October, 1876.	November, 1876.	Quarter ending November 30, 1876.	December, 1876.	January, 1877.	February, 1877.	Quarter ending February 28, 1877.	
Eastport, Me.	32.3	35.1	38.1	35.1	41.7	46.5	49.6	46.1	50.3	49.9	46	48.7	39.5	31.2	29.5	33.4	40.8
Portland, Me.	33.6	37.5	45.6	38.9	55.4	63	62.1	60.2	56.2	49.5	41.6	50	34.7	30.5	33.4	32.9	45.5
Wood's Holl, Mass.	33.9	43	51.9	42.9	68.4	74.6	73	71	58.2	56.3	47.8	54.4	33.7	29.5	31.3	31.5	43.9
New London, Conn.	37.5	44.4	53.7	45.1	63.2	70.8	73.7	69.9	65.4	57.2	50.1	57.7	38.6	33.9	35.5	33.9	52.1
New York, N. Y.	33.1	39.4	50.6	41.7	67.4	71.5	72.9	70.4	64.4	59.7	46.5	54.5	32.3	28.1	32.2	30.8	49.1
Baltimore, Md.	41.6	50.8	63.9	51.7	76.9	83.6	75.2	78.5	70.6	57.9	50.6	58.6	34.9	32.1	33.3	33.3	53.7
Norfolk, Va.	48.5	57.2	67.6	57.7	79.1	82.3	77.7	79.7	67.6	60.1	53.6	60.4	36.6	38.1	43.4	39.3	59.2
Kitty Hawk, N. C. ....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Wilmington, N. C.	53.1	61.8	71.5	66.1	73.1	81.2	80.2	72.8	77.2	65.2	57.6	66.7	43.8	42.4	49.3	45.1	64.1
Charleston, S. C.	58.5	64.1	72.6	65	79.9	83.1	84.9	83.3	81	65.7	60.8	64.2	46.6	42.2	52.2	49	65.3
Savannah, Ga.	56.3	60.1	67	61.1	71.8	77.2	82.8	77.2	81	.....	53.3	.....	44.2	48.4	51.5	47.8	.....
Jacksonville, Fla.	64.7	3.3	80.9	77.8	83	88.3	87.5	87	85.9	72.6	67.7	75.5	51	56.5	58.8	55.5	73.9
Kew West, Fla.	75.2	78.7	82.7	77.5	86.1	86.2	85.9	86	87.3	81.2	73.9	80.8	66.3	72.8	68.9	69.3	78.4

APPENDIX G.

A TABLE SHOWING COMPARATIVE AMOUNTS OF MENHADEN, MACKEREL, SHAD, ALEWIVES INSPECTED IN THE STATE OF MASSACHUSETTS.

MASSACHUSETTS INSPECTIONS.

Years.	Shad.	Alewives.	Menhaden.	Mackerel.
	<i>Barrels.</i>	<i>Barrels.</i>	<i>Barrels.</i>	<i>Barrels.</i>
1804.....	57	4,551 $\frac{1}{2}$	3,642 $\frac{1}{2}$	7,857 $\frac{1}{2}$
1805.....	183 $\frac{1}{2}$	4,009	3,410	8,533 $\frac{1}{2}$
1806.....	50	4,518 $\frac{1}{2}$	4,951 $\frac{1}{2}$	8,220 $\frac{1}{2}$
1807.....	22	7,638 $\frac{1}{2}$	3,786 $\frac{1}{2}$	9,305
1808.....	147	1,685	1,306	7,620 $\frac{1}{2}$
1809.....	311	7,287	3,024	8,825
1810.....	201	6,524 $\frac{1}{2}$	2,524	12,552 $\frac{1}{2}$
1811.....	1,443	5,885 $\frac{1}{2}$	7,148	17,401
1812.....	822	4,971	1,155	5,881
1813.....	822 $\frac{1}{2}$	1,905 $\frac{1}{2}$	90 $\frac{1}{2}$	3,758 $\frac{1}{2}$
1814.....	214	673	10 $\frac{1}{2}$	1,339
1815.....	526	1,770 $\frac{1}{2}$	2,306	16,039 $\frac{1}{2}$
1816.....	379 $\frac{1}{2}$	1,593	3,945	31,269
1817.....	46 $\frac{1}{2}$	1,440	4,238	37,362
1818.....	244	998 $\frac{1}{2}$	4,512	46,318
1819.....	93 $\frac{1}{2}$	792 $\frac{1}{2}$	4,640 $\frac{1}{2}$	100,101
1820.....	50 $\frac{1}{2}$	476 $\frac{1}{2}$	1,338	115,641
1821.....	21 $\frac{1}{2}$	642 $\frac{1}{2}$	534	111,009 $\frac{1}{2}$
1822.....	41	2,155 $\frac{1}{2}$	237	100,294 $\frac{1}{2}$
1823.....	63	3,967 $\frac{1}{2}$	305	145,006
1824.....	53 $\frac{1}{2}$	4,037	987	191,650 $\frac{1}{2}$
1825.....	364	3,653	697	254,384 $\frac{1}{2}$
1826.....	313	2,938	924	158,740 $\frac{1}{2}$
1827.....	283	1,864	164	190,304 $\frac{1}{2}$
1828.....	607	2,731	353	237,321 $\frac{1}{2}$
1829.....	653 $\frac{1}{2}$	3,437	226	225,977 $\frac{1}{2}$
1830.....	152 $\frac{1}{2}$	3,030	97	303,463 $\frac{1}{2}$
1831.....	1,063 $\frac{1}{2}$	3,036	1,147	3-3,548 $\frac{1}{2}$
1832.....	105	1,755	300	222,454
1833.....	321	2,266	4-0	222,932 $\frac{1}{2}$
1834.....	3	4,315 $\frac{1}{2}$	1,008	252,775 $\frac{1}{2}$
1835.....	309 $\frac{1}{2}$	5,685 $\frac{1}{2}$	1,443	194,800 $\frac{1}{2}$
1836.....	527	4,979	1,488	174,410 $\frac{1}{2}$
1837.....	652	1,182	461	134,157 $\frac{1}{2}$
1838.....	3-0	604	1,164	116,740 $\frac{1}{2}$
1839.....	773	2,769	10,883	74,565 $\frac{1}{2}$
1840.....	856	1,474	1,427	50,491 $\frac{1}{2}$
1841.....	3,910	2,840	2,138	55,517
1842.....	2,831	7,126	566	75,543
1843.....	903	5,554	854	61,451
1844.....	1,679	6,303	476	85,331 $\frac{1}{2}$
1845.....	1,377	4,714	272	202,302 $\frac{1}{2}$
1846.....	517	2,626 $\frac{1}{2}$	525	179,311 $\frac{1}{2}$
1847.....	474	3,843	132	251,917 $\frac{1}{2}$
1848.....	228 $\frac{1}{2}$	1,899 $\frac{1}{2}$	137	300,130 $\frac{1}{2}$
1849.....	331	2,152	78	203,950
1850.....	503	1,629	137	242,674
1851.....	180 $\frac{1}{2}$	1,358 $\frac{1}{2}$	.....	329,244 $\frac{1}{2}$
1852.....	195	1,604	107	198,150
1853.....	168 $\frac{1}{2}$	1,580	.....	133,340 $\frac{1}{2}$
1854.....	225 $\frac{1}{2}$	1,645	.....	135,349 $\frac{1}{2}$
1855.....	238 $\frac{1}{2}$	2,775	.....	211,956 $\frac{1}{2}$
1856.....	265	2,740 $\frac{1}{2}$	63	214,312
1857.....	473 $\frac{1}{2}$	2,497	203	163,705 $\frac{1}{2}$
1858.....	197 $\frac{1}{2}$	2,835 $\frac{1}{2}$	.....	131,603 $\frac{1}{2}$
1859.....	421 $\frac{1}{2}$	2,499 $\frac{1}{2}$	600	99,715 $\frac{1}{2}$
1860.....	487 $\frac{1}{2}$	1,604	360	235,685 $\frac{1}{2}$
1861.....	73 $\frac{1}{2}$	355	.....	194,2-3 $\frac{1}{2}$
1862.....	61 $\frac{1}{2}$	821 $\frac{1}{2}$	250	260,864 $\frac{1}{2}$
1863.....	56 $\frac{1}{2}$	529	425	306,912 $\frac{1}{2}$
1864.....	29	390	.....	274,357 $\frac{1}{2}$
1865.....	261	511	630	256,796 $\frac{1}{2}$
1866.....	10 $\frac{1}{2}$	592	6 $\frac{1}{2}$	231,696 $\frac{1}{2}$
1867.....	103 $\frac{1}{2}$	342 $\frac{1}{2}$	250	210,314 $\frac{1}{2}$
1868.....	2 $\frac{1}{2}$	118	.....	180,056 $\frac{1}{2}$
1869.....	.....	87 $\frac{1}{2}$	.....	234,210 $\frac{1}{2}$
1870.....	.....	65 $\frac{1}{2}$	450	318,521 $\frac{1}{2}$
1871.....	12 $\frac{1}{2}$	56	229	259,416 $\frac{1}{2}$
1872.....	15 $\frac{1}{2}$	424	.....	181,956 $\frac{1}{2}$
1873.....	2 $\frac{1}{2}$	550	.....	185,748 $\frac{1}{2}$
1874.....	142 $\frac{1}{2}$	303	220	258,379 $\frac{1}{2}$
1875.....	65 $\frac{1}{2}$	269 $\frac{1}{2}$	.....	130,002 $\frac{1}{2}$
1876.....	763	388 $\frac{1}{2}$	9	225,943 $\frac{1}{2}$
1877.....	4	357 $\frac{1}{2}$	52	105,097 $\frac{1}{2}$

APPENDIX H.

LIST OF MANUFACTURERS OF MENHADEN OIL AND GUANO, 1877.

[The following table was furnished by Mr. Jasper Pryer.]

Name of manufacturer.	Location of factory.	Winter address.
G. S. Allyn & Co.	Mystic River, Conn.	Mystic River, Conn.
O. H. Almy & Co. (E. J. Corey, agent)	Tiverton Four Corners, R. I.	Tiverton Four Corners, R. I.
Barren Island Manufacturing Company	Barren Island, N. Y.	58 Broad street, New York City.
William J. Brightman & Co.	Tiverton, R. I.	Tiverton, R. I.
J. H. Bishop	Madison, Conn.	Madison, Conn.
Bristol Oil Works	Round Pond, Me.	Round Pond, Me.
Brown's Cove Company	do	do.
Isaac Brown & Co.	Tiverton, R. I.	Tiverton, R. I.
Nelson Burnett	Southampton, N. Y.	Southampton, N. Y.
Cape Cod Oil Works (J. Cook)	Provincetown, Mass.	Provincetown, Mass.
B. C. Cartwright	Shelter Island, N. Y.	Shelter Island, N. Y.
Joseph Church & Co.	Round Pond, Me.	Tiverton, R. I.
G. H. Clark	East Marion, N. Y.	East Marion, N. Y.
Charles Cook	Tiverton Four Corners, R. I.	Tiverton Four Corners, R. I.
Captain C. Doughty	Somers Point, N. J.	Somers Point, N. J.
W. Y. Fithian & Co.	Amagansett, N. Y.	Southold, N. Y.
Robert A. Friend	Brooklin, Me.	Brooklin, Me.
Ford, Avery & Co.	Tangier Island, Md.	
Fowler, Foot & Co.	South Bristol, Me.	Guilford, Conn.
Gallup & Holmes	Boothbay, Me.	Groton, Conn.
Gallup, Morgan & Co.	do	do.
Albert Gray & Co.	Round Pond, Me.	Tiverton, R. I.
Thomas F. Gray	Tiverton, R. I.	do.
W. H. H. Glover	Southold, N. Y.	Southold, N. Y.
Green Brothers	Amagansett, N. Y.	Davisville, R. I.
Griffin & Vail	Port Monmouth, N. J.	Riverview, N. Y.
W. D. Hall	Millenbeck, Va.	Millenbeck, Va.
F. J. Harker	Hampton, Va.	Hampton, Va.
J. S. Havens	Patchogue, N. Y.	Riches, N. Y.
Hawkins Brothers	Shelter Island, N. Y.	Jamesport, N. Y.
Hawkins Brothers	Barren Island, N. Y.	do.
W. H. H. Howland	Portsmouth, R. I.	Tiverton, R. I.
Seaman Jones & Co.	Barren Island, N. Y.	134 Third avenue, New York City.
E. K. Kelsey	Branford, Conn.	Clinton, Conn.
Kenniston, Cobb & Co.	Booth Bay, Me.	Boothbay, Me.
Loud's Island Oil Company	Round Pond, Me.	Round Pond, Me.
Luce Brothers	Niantic, Conn.	East Lyme, Conn.
Maddocks' Oil Works	Booth Bay, Me.	Boothbay, Me.
Manokin Oil Works	Somerset County, Md.	
Anthony Manchester	Tiverton Four Corners, R. I.	Tiverton Four Corners, R. I.
B. F. Manchester	Somers Point, N. J.	Somers Point, N. J.
James Manchester	Tiverton, R. I.	Tiverton, R. I.
The George W. Miles Company	South Bristol, Me.	Millford, Conn.
Morris & Fildel	Somers Point, N. J.	Somers Point, N. J.
North American Oil Works	Wellfleet, Mass.	Wellfleet, Mass.
James E. Otis	Tuckerton, N. J.	Saybrook, Conn.
Pemaquid Oil Works	Bristol, Me.	Bristol, Me.
Erskine Pierce	Dartmouth, Mass.	Dartmouth, Mass.
F. F. Pierce	Greenport, N. Y.	Greenport, N. Y.
Joseph D. Parsons	Springs, N. Y.	Springs, N. Y.
G. H. Payne	Deep Hole, Easthampton, N. Y.	Sig Harbor, N. Y.
Quinnipiac Fertilizer Company (H. L. Dudley, agent.)	Pine Island, Conn.	New Haven, Conn.
J. Harrison Raynor	Greenport, N. Y.	Greenport, N. Y.
W. C. Raynor	Westhampton, N. Y.	Westhampton, N. Y.
Round Pond Oil Works	Round Pond, Me.	Round Pond, Me.
Amasa Simmons (Herman Smith, agent)	Tiverton Four Corners, R. I.	Tiverton Four Corners, R. I.
Cyrus H. Smith	Tuckerton, N. J.	Tuckerton, N. J.
Smith, Green & Co.	Sayville, N. Y.	Sayville, N. Y.
Smith & Yerrington	do	do.
South Bay Oil Company	do	do.
South St. George Oil Works	South Saint George, Me.	South Saint George, Me.
John Southworth	Portsmouth, R. I.	Fall River, Mass.
Suffolk Oil Company	Boothbay, Me.	Boston, Mass.
Tuthill, French & Co.	East South Bristol, Me.	Greenport, N. Y.
George F. Tuthill	Greenport, N. Y.	do.
Virginia Oil & Guano Company (O. E. Malby, president.)	Norfolk, Va.	Norfolk, Va.
Benjamin Waites	Tiverton Four Corners, R. I.	Tiverton Four Corners, R. I.
Waley & Co.	Poquonnock Bridge, Conn.	Poquonnock Bridge, Conn.
Wells & Co.	South Bristol, Me.	Greenport, N. Y.
Isaac G. White	Tiverton Four Corners, R. I.	Tiverton Four Corners, R. I.
Wilcox & Manchester	do	do.

List of manufacturers of menhaden oil and guano, 1877—Continued.

Name of manufacturer.	Location of factory.	Winter address.
Leander Wilcox & Co.....	Mystic Bridge, Conn.....	Mystic Bridge, Conn.
Job T. Wilson.....	Fall River, Mass.....	Fall River, Mass.
W. W. Warner.....	Good Ground, N. Y.....	Good Ground, N. Y.
Henry E. Wells.....	Greenport, N. Y.....	Greenport, N. Y.
Westbrook Oil Company.....	Westbrook, Conn.....	Westbrook, Conn.

APPENDIX I.

PARTIAL LIST OF VESSELS EMPLOYED IN THE MENHADEN FISHERY.

STEAMERS.

Name.	Tonnage.	Owner.	Port of entry.	Where fishing.
Mabel Bird.....	80	L. Maddocks.....	Boothbay, Me.....	Maine.
M. W. Fish.....	80	do.....	do.....	Do.
Grace Darle.....	85	do.....	do.....	Do.
Phebe.....	70	do.....	do.....	Do.
S. L. Goodale.....	70	do.....	do.....	Do.
H. M. Pirce.....	20	do.....	do.....	Do.
Job T. Wilson.....		J. S. Nickerson.....	Hodgdon's Mills, Me..	Do.
Leonard Brightman.....		do.....	do.....	Do.
Emma.....		Thomas Nichols.....	Round Pond, Me.....	Do.
		do.....	do.....	Do.
		Pemaquid Oil Comp'y	do.....	Do.
		Tuthill, French & Co..	South Bristol, Me....	Do.
		do.....	do.....	Do.
		do.....	do.....	Do.
Hunter.....	90	Jonathan Bowrne, jr.	New Bedford, Mass....	Do.
George H. Bradley.....	53	do.....	do.....	Do.
Belle and Hattie.....	57	do.....	do.....	Do.
Nellie E. Rawson.....	56	do.....	do.....	Do.
Geo. W. Hunt.....	54	do.....	do.....	Do.
David H. Wilson.....		Job T. Wilson.....	Fall River, Mass.....	Do.
Chance-Shot.....	59	George Devoll.....	do.....	Do.
Lottie W. Merrill.....		W. J. Brightman.....	Tiverton, R. I.....	Do.
Paulina Wilbor.....		do.....	do.....	Do.
Fearless.....	70	do.....	do.....	Do.
Kingfisher.....		do.....	do.....	Do.
A. M. Hathaway.....		Joseph Church & Co..	do.....	Do.
Joseph Church.....		do.....	do.....	Do.
Ospray.....		do.....	do.....	Do.
Jemima Boomer.....		do.....	do.....	Do.
Bessie Sims.....		do.....	do.....	Do.
George W. Humphrey.....		do.....	do.....	Do.
Seven Brothers.....		do.....	do.....	Do.
		Charles Cook.....	Tiverton Four Corners, R. I.	Do.
Grace.....		Isaac D. Manchester..	Newport, R. I.....	Do.
E. T. De Blois.....	81 ³ / ₁₆	E. T. De Blois.....	Portsmouth, R. I.....	Do.
Albert Brown.....	78 ⁹ / ₁₆	do.....	do.....	Do.
Wm. A. Wells.....	51 ⁵ / ₁₆	do.....	do.....	Do.
G. Polhemus.....		Gallup, Holmes & Co..	Groton, Conn.....	Connecticut.
Aeronaut.....		do.....	do.....	Do.
H. T. Sisson.....		do.....	do.....	Do.
Gypsy Girl.....		do.....	do.....	Do.
Daisy.....	66	Gallup, Morgan & Co.	do.....	Do.
Jno. A. Morgan.....	87	do.....	do.....	Do.
		Gallup & Manchester..	do.....	Do.
		do.....	do.....	Do.
Luce Bros.....	76	Luce Bros.....	East Lyme, Conn.....	Do.
Emily Foote.....		Fowler & Foote.....	Guilford, Conn.....	Do.
		George W. Miles Co....	Milford, Conn.....	Do.
		do.....	do.....	Do.
Wm. Spicer.....		Quinnipiac Fertilizer Company.	New London, Conn....	Do.
Price.....		Frank Price.....	Greenport, N. Y.....	Long Island.
Newins.....		do.....	do.....	Do.
Lizzie.....		do.....	do.....	Do.
Colburn.....		do.....	do.....	Do.
Wm. Floyd.....	60	Hawkins Bros.....	Jamesport, N. Y.....	Do.
E. S. Havens.....	60	do.....	do.....	Do.
George T. Morse.....	70 ¹ / ₂	do.....	do.....	Do.
Oak.....		do.....	Greenport, N. Y.....	Do.
Cambria.....		do.....	do.....	Do.

Partial list of vessels employed in the menhaden fishery—Continued.

SAILING-VESSELS.

Name.	Tonnage.	Owner.	Port of entry.	Where fishing.
E. B. Church.....	40	W. J. Brightman.....	Tiverton, R. I.....	Maine.
Dragonet.....	30	do.....	do.....	Do.
Penikese.....	25	do.....	do.....	Do.
Willie E. Brightman.....	22	do.....	do.....	Do.
Long Island.....	11	do.....	do.....	Do.
Gracie.....	12	do.....	do.....	Do.
Sunbeam.....	12	do.....	do.....	Do.
Dora.....	9	do.....	do.....	Do.
D. T. Vail.....	32	Gurdon S. Allyn.....	Mystic, Conn.....	Connecticut.
Hadley.....	14	do.....	do.....	Do.
Hepsie.....	18 $\frac{44}{100}$	do.....	do.....	Do.
Ramble.....	14 $\frac{14}{100}$	do.....	do.....	Do.
Flash.....	10 $\frac{75}{100}$	do.....	do.....	Do.
C. A. Sounds.....	16 $\frac{85}{100}$	do.....	do.....	Do.
Annie.....	19 $\frac{76}{100}$	do.....	do.....	Do.
J. W. Luce.....	22	Luce Bros.....	East Lyme, Conn.....	Do.
Success.....	22	do.....	do.....	Do.
Rustic.....	19	do.....	do.....	Do.
Flirt.....	19	do.....	do.....	Do.
Liza A. Luce.....	17	do.....	do.....	Do.
Nettie J. Luce.....	16	do.....	do.....	Do.
Nevada.....	17	do.....	do.....	Do.
Pacific.....	9	do.....	do.....	Do.
Haze.....	22	do.....	do.....	Do.
Col. Morgan.....		Greene Brothers.....	Greenport, N. Y.....	Long Island.
M. A. Greco.....		do.....	do.....	Do.
Allie.....		do.....	do.....	Do.
Phoenix.....		do.....	do.....	Do.
Elnora.....		do.....	do.....	Do.
Annat Pitcher.....		do.....	do.....	Do.
Mistonax.....		do.....	do.....	Do.
Swan.....	24 $\frac{64}{100}$	Sterling Company.....	do.....	Do.
Mary H. Sisson.....	20 $\frac{95}{100}$	do.....	do.....	Do.
Dauntless.....	19 $\frac{70}{100}$	do.....	do.....	Do.
Bunker City.....	8 $\frac{100}{100}$	do.....	do.....	Do.
Rough & Ready.....	10 $\frac{24}{100}$	do.....	do.....	Do.
Sarah.....	10 $\frac{37}{100}$	do.....	do.....	Do.
Kate Romer.....	9 $\frac{83}{100}$	do.....	do.....	Do.
Friendly.....	13 $\frac{37}{100}$	do.....	do.....	Do.
John Marcy.....	12 $\frac{60}{100}$	do.....	do.....	Do.
Annie Homan.....	22	Wm. G. Fithian & Co.....	Napeague.....	Do.
Eureka.....	21	do.....	do.....	Do.
Wm. Downs.....	18	do.....	do.....	Do.
Jessie Smith.....	14	do.....	do.....	Do.
Native.....	14	do.....	do.....	Do.
G. P. Horton.....	14	do.....	do.....	Do.
Eliza Maria.....	14	do.....	do.....	Do.
	12	Hawkins Brothers.....	Jamesport, N. Y.....	Do.
Peerless.....	22	do.....	do.....	Do.
Sirocco.....	22	do.....	do.....	Do.
Starlight.....	22	do.....	do.....	Do.
Simoon.....	12	do.....	do.....	Do.
Typhoon.....	12	do.....	do.....	Do.
Young America.....	12	do.....	do.....	Do.
Clyde.....	12	do.....	do.....	Do.
Geo. Nelson.....	12	do.....	do.....	Do.
Pelican.....	12	do.....	do.....	Do.
	12	do.....	do.....	Do.
Rob't Mills.....	10	Seaman Jones.....	Barren Island, N. Y.....	Do.
Golden Rule.....	15	do.....	do.....	Do.
Morning Light.....	15	do.....	do.....	Do.
N. M. Preston.....	15	do.....	do.....	Do.
McClane.....	15	do.....	do.....	Do.
Madeline.....	15	do.....	do.....	Do.
V. Koon.....	24	do.....	do.....	Do.
Rosa Belle.....	19	do.....	do.....	Do.
Lizzie Lane.....	19	do.....	do.....	Do.

APPENDIX K.

PRICES CURRENT OF MENHADEN OIL. 1871-1878.

Date.	Select light.	Choice brown.	Inferior to dark.	Gurry.	Strained.	Pressed.
	Cents per gallon.	Cents per gallon.	Cents per gallon.	Cents per gallon.	Cents per gallon.	Cents per gallon.
1871.						
October 18	41 to 42	39½ to 40½	35 to 38	20 to 25		
October 25	41 to 41½	39½ to 40½	35 to 38	20 to 25		
November 1	40½ to 41	39½ to 40	35 to 38	20 to 25		
November 8	45 to 47½	42½ to 45	40 to 42½	25 to 30		
November 15	50	47½ to 50	40 to 45	30 to 35		
November 22	52	47½ to 50	45 to 47½	30 to 35		
November 29	52½ to 55	50 to 52	47½ to 50	35 to 40		
December 6	52½ to 55	50 to 52	47½ to 50	35 to 40	60 to 62½	
December 13	55	52½	47½ to 50	35 to 40	58 to 60	
December 20	55	52½	47½ to 50	35 to 40	53 to 60	
December 27	53 to 55	52½	47½ to 50	30 to 40	58 to 60	
1872.						
January 3	55	52½	47½ to 50	30 to 40	58 to 65	
January 10	55 to 57½	52½	47½ to 50	33 to 45	58 to 65	
January 17	55 to 57½	52½	47½ to 50	35 to 45	58 to 65	
January 24	55	52½	47½ to 50	35 to 45	60 to 65	
January 31	55 to 56	52½	47½ to 50	35 to 45	60 to 65	
February 7	55 to 56	52½	47½ to 50	35 to 45	60 to 65	
February 14	55	52½	47½ to 50	35 to 45		60 to 65
February 21	55	52½	47½ to 50	35 to 45		60 to 65
February 28	54	52½	47½ to 50	35 to 45		60 to 65
March 6	53½ to 55	51 to 52½	46 to 48	35 to 45		60 to 62½
March 13	53 to 54	51 to 52	45 to 48	35 to 45		60
March 20	52 to 54	51	45 to 48	35 to 45		60 to 61
March 27	55 to 56	53 to 54	48 to 50	40 to 45		60 to 65
April 3	60	57½		40 to 45		60 to 65
April 10	62½	60		40 to 45		63 to 65
April 17	62½ to 65	60 to 62½	55 to 57½	45		64 to 66
April 24	62 to 64	60 to 62	55 to 57	45		64 to 66
May 1	60 to 62	60	55 to 57½	45		64 to 66
May 8	60	58 to 59	55 to 57	45		63 to 65
May 15	58 to 60	54 to 56	50 to 52½	45 to 47½		61 to 63
May 22	55 to 57½	50 to 52½	45 to 47½			60 to 63
May 29	48 to 50	45 to 47½	40 to 42½			60 to 61
June 5	47	43 to 44	40			52 to 55
June 12	40 to 42½	37 to 39	36 to 38			45 to 50
June 19	40 to 42½	37 to 39	36 to 38			45 to 50
June 26	41 to 42	40 to 41	37 to 39			45 to 47½
July 3	47 to 48	45 to 46	43 to 44			47 to 49
July 10	46 to 47	42½ to 44	40 to 42			47 to 49
July 17	44 to 45	42½ to 43	40 to 42			46 to 48
July 24	44 to 45	42½ to 43	40 to 42			47 to 50
July 31	47 to 48	45 to 46	40 to 42			48 to 50
August 7	44 to 45	43	40			
August 14	44	43	38 to 40	25 to 30		
August 21	44 to 45	43 to 44	40	25 to 30		
August 28	43 to 44	42 to 43	40	25 to 30		
September 4	43 to 44	42 to 43	40	25 to 30		
September 11	44½ to 45	43 to 42	40	25 to 35		
September 18	45 to 47	43 to 44	40 to 42	25 to 35		
September 25	50 to 52	47 to 49	44 to 46	28 to 38		
October 2	51 to 52	50	45 to 48	35 to 40		
October 9	51	50	45 to 48	35 to 40		
October 16	50	48 to 49	44 to 46	35 to 40		
October 23	50 to 52½	48 to 49	44 to 46	35 to 40		
October 30	50	48 to 49	44 to 46	35 to 40		
November 6	50	48 to 49	44 to 46	35 to 40		
November 13	50	48 to 49	44 to 46	35 to 40		
November 20	54 to 55	50 to 52½	46 to 48	35 to 42		
November 27	55	53 to 54	50 to 51	40 to 42		
December 4	56	54 to 55	52 to 53	45 to 50		
December 11	55	52½ to 55	48 to 50	45 to 47		
December 18	55 to 56	52½ to 55	48 to 50	45 to 47		
December 25	55 to 56	52½ to 55	48 to 50	45 to 47		
1873.						
January 1	55 to 56	52½ to 55	48 to 50	45 to 47		53 to 57½
January 8	58	56 to 57	52 to 55	48 to 50		
January 15	58	56 to 57	52 to 55	48 to 50		

Prices current of menhaden oil—Continued.

Date.	Select light.	Choice brown.	Inferior to dark.	Gurry.	Strained.	Pressed.
	Cents per gallon.	Cents per gallon.	Cents per gallon.	Cents per gallon.	Cents per gallon.	Cents per gallon.
1873.						
January 22.....	58	56 to 57	52 to 55	48 to 50		
January 29.....	58	57	55	50		
February 5.....	58	57	55	50		
February 12.....	60	59	58			
February 19.....	60	59	58			
February 26.....	60	59 to 60				
March 5.....	60	59 to 60				
March 12.....	60	59 to 60				
March 19.....	60	59 to 60				
March 26.....	60	59 to 60				
April 2.....	60 to 62	60				
April 9.....	60	60				
April 16.....	60	58 to 60				
April 23.....	60	58 to 60				
April 30.....	57½ to 60					
May 7.....	55½ to 60					
May 14.....	55 to 57½					
May 21.....	56					
May 28.....	55 to 56					
June 4.....	52½ to 55	50				
June 11.....	52½ to 55	50				
June 18.....		51	50			
June 25.....	51	50				
July 2.....	50	49 to 50	47½			
July 9.....	50	49 to 50	47½			
July 16.....	42½	40 to 42	37½			
July 23.....	41	40 to 41	37½			
July 30.....	40	39 to 40	37½			
August 6.....	40	39 to 40	37½			
August 13.....	40 to 41	39 to 40	37½			
August 20.....	41½ to 45	41 to 42	38 to 40			
August 27.....	45	44 to 45	40 to 43			
September 3.....	45	44 to 45	40 to 43			
September 10.....	45	44 to 45	40 to 43			
September 17.....	45	44 to 45	40 to 43			
September 24.....	45	44 to 45	40 to 43			
October 1.....	43 to 45	40 to 43				
October 8.....	42 to 44	40 to 42				
October 15.....	40 to 41	40				

Date.	Select light.	Choice brown.	Inferior dark.	Select light, strained.
	Cents per gallon.	Cents per gallon.	Cents per gallon.	Cents per gallon.
1873.				
October 22.....	40 to 41	40		
October 29.....	38 to 40	37½		
November 5.....	37½	36 to 37		
November 12.....	33 to 35	31 to 32	30	
November 19.....	32½ to 35	30 to 32	29	
November 26.....	33 to 35	33	30	
December 3.....	38 to 40	37½	35	
December 10.....	41	40	35	
December 17.....	40 to 42½	40	35 to 37½	
December 24.....	40 to 42½	40	35 to 37½	
December 31.....	40 to 42½	40	35 to 37½	
1874.				
January 7.....	40 to 42½	40	35 to 37½	
January 14.....				
January 21.....	45	45	40 to 42½	
January 28.....	44 to 45	44	40 to 42½	
February 4.....	45 to 47½	45	42½ to 43	
February 11.....	45 to 47½	45 to 46	42½ to 45	
February 18.....	47½		42½ to 45	
February 25.....	45 to 47½		42½ to 45	
March 4.....	45 to 47½		42½ to 45	52½ to 55
March 11.....	45		42½ to 55	52½ to 55

Prices current of menhaden oil—Continued.

Date.	Select light.	Select light, strained.	Choice brown.	Inferior to dark.
1874.	<i>Cents per gallon.</i>	<i>Cents per gallon.</i>	<i>Cents per gallon.</i>	<i>Cents per gallon.</i>
March 18.....	42½ to 45	52½ to 55	.....	40 to 42
March 25.....	43 to 45	52½ to 55	.....	40 to 42
April 1.....	43 to 45	52½ to 55	42 to 43	40 to 42
April 8.....	41 to 42	52½ to 55	40 to 41	38 to 40
April 15.....	41 to 42	50	41	.....
April 22.....	41 to 42	50	41	.....
April 29.....	41 to 42	50	41	.....
May 6.....	40 to 42	48 to 50	.....	.....
May 13.....	40 to 42	48 to 50	.....	.....
May 20.....	40 to 41	46 to 47	.....	.....
May 27.....	40 to 41	46 to 47	.....	.....
June 3.....	40	46	.....	.....
June 10.....	37 to 39	44 to 45	.....	.....
June 17.....	37 to 39	44 to 45	.....	.....
June 24.....	35 to 37	42 to 43	35	32 to 34
July 1.....	.....	.....	.....	.....
July 8.....	37 to 39	43 to 45	37	34 to 36
July 15.....	36 to 37	42 to 43	36	34 to 36
July 22.....	35 to 36	41 to 42	35	32 to 34
July 29.....	36	41 to 42	35	32 to 34
August 5.....	36	40 to 42	35 to 35½	32 to 34
August 12.....	36	40 to 42	35 to 35½	32 to 34
August 19.....	36	40 to 42	35 to 35½	32 to 34
August 26.....	36	40 to 42	35 to 35½	32 to 34
September 2.....	36	40 to 42	35 to 35½	32 to 34
September 9.....	26 to 37	40 to 42	35 to 35½	32 to 34
September 16.....	36 to 37	40 to 42	35 to 35½	32 to 34
September 23.....	36 to 37	40 to 42	35 to 35½	32 to 34
September 30.....	36 to 38	40 to 42	35 to 36	32 to 34
October 7.....	36 to 38	40 to 42	35 to 36	32 to 34
October 14.....	39 to 40	44	37 to 38	35 to 36
October 21.....	40 to 42	46 to 48	38 to 39	36 to 38
October 28.....	42 to 43	48 to 50	40 to 42	38 to 40
November 4.....	42 to 43	48 to 50	41 to 42	38 to 40
November 11.....	41 to 42	47 to 49	40 to 41	38 to 39
November 18.....	40 to 41	45 to 46	36 to 40	37 to 39
November 25.....	40 to 41	45 to 46	36 to 40	37 to 39
December 2.....	40 to 41	45 to 46	39 to 40	37 to 39
December 9.....	40 to 41	45 to 46	39 to 40	37 to 39
December 16.....	40 to 41	45 to 46	39 to 40	37 to 39
December 23.....	40	45 to 46	38 to 40	35 to 36
December 30.....	38 to 40	45 to 46	38	35 to 36
1875.				
January 6.....	38 to 40	45 to 46	38	35 to 36
January 13.....	38 to 40	44 to 46	38 to 40	35 to 36
January 20.....	40	44 to 46	40	36 to 38
January 27.....	40 to 42	44 to 46	40	36 to 38
February 3.....	40 to 42	44 to 46	40	36 to 38
February 10.....	42	44 to 46	41	36 to 38
February 17.....	42	44 to 46	41	36 to 38
February 24.....	43 to 44	45 to 46	43	36 to 38
March 3.....	43 to 44	45 to 46	42 to 43	36 to 38
March 10.....	42 to 43	45 to 46	42	36 to 38
March 17.....	41 to 42	45 to 46	40 to 41	36 to 38
March 24.....	41 to 42	45 to 46	40	36 to 38
March 31.....	41	45 to 46	40	36 to 38
April 7.....	41	45 to 46	40	36 to 38
April 14.....	41	45 to 46	40	36 to 38
April 21.....	41 to 42	45 to 46	40	36 to 38
April 28.....	44 to 46	.....	41 to 42	38 to 40
May 5.....	45 to 46	49 to 50	42 to 43	38 to 40
May 12.....	44 to 45	49 to 50	41 to 42	38 to 40
May 19.....	42 to 44	49 to 50	41 to 42	25 to 40
May 26.....	40 to 41	49 to 50	39 to 40	25 to 30
June 2.....	40	47 to 48	37 to 38	25 to 30

302 REPORT OF COMMISSIONER OF FISH AND FISHERIES.

Prices current of menhaden oil—Continued.

Date.	Select light.	Select light, strained.	Bleached.	Choice brown.	Inferior to dunk.
1875.	Cents per gallon.	Cents per gallon.	Cents per gallon.	Cents per gallon.	Cents per gallon.
June 9	38 to 39	44 to 45	50	57 to 38	25 to 30
June 16	38 to 39	44 to 45	50	37 to 38	25 to 35
June 23	38 to 39	44 to 45	50	37 to 38	25 to 35
June 30	36 to 37	44 to 45	50	35 to 36	25 to 33
July 7	36 to 37	41 to 45	49 to 50	35	25 to 33
July 14	35 to 36	44 to 45	49 to 50	35	25 to 33
July 21	35 to 36	41 to 45	49 to 50	35	25 to 33
July 28	35 to 36	42 to 44	47½ to 48	33½ to 35	25 to 34
August 4	34½ to 35	40 to 41	45 to 46	33 to 34	25 to 33
August 11	33	38 to 40	44 to 46	33	25 to 30
August 18	32 to 33	38 to 40	44 to 46	32	25 to 31
August 25	32 to 33½	38 to 40	44 to 46	32	25 to 31
September 1	32	38	44 to 45	31	25 to 30
September 8	32	38	44 to 45	31	25 to 30
September 15	32 to 33	38	44 to 45	31 to 32	20 to 30
September 22	32 to 33	38	44 to 45	32	20 to 30
September 29	33	38	44 to 46	32 to 33	20 to 30
October 6	34 to 35	38	44 to 46	32 to 33	20 to 30
October 13	34 to 35	38	44 to 46	32 to 33	20 to 30
October 20	36	40 to 42	50	34 to 36	
October 27	40 to 41	44 to 45	52 to 54	40	
November 3	40 to 41	44 to 45	52½ to 54	40	
November 10	40 to 41	44 to 45	52½ to 55	40	
November 17	40 to 41	44 to 45	52½ to 55	40	
November 24	41 to 42	46 to 48	52½ to 55	40 to 41	
December 1	42 to 44	46 to 48	52½ to 55	41 to 42	
December 8	42 to 44	46 to 48	52½ to 55	41 to 42	
December 15	41 to 45	48	54 to 55	42 to 43	
December 22	45 to 47½	46 to 48	55 to 56	43 to 44	
December 29	45 to 47½	46 to 48	55 to 56	43 to 44	
1876.					
January 5	47½ to 50	48 to 50	55 to 56	45 to 47½	
January 12	47½ to 50	50 to 52	55 to 60	45 to 47½	
January 19	47½ to 50	50 to 52	55 to 60	45 to 47½	
January 26	47½ to 50	50 to 52	55 to 60	45 to 47½	
February 2	47½ to 50	50 to 52	55 to 60	45 to 47½	
February 9	47½ to 50	50 to 52	55 to 60	45 to 47½	
February 16	48 to 50	50 to 52	55 to 58	45 to 47½	
February 23	48 to 50	50 to 52	55 to 58	45 to 47½	
March 1	48 to 50	50 to 52	55 to 58	45 to 47½	
March 8					
March 15	47 to 48	50 to 52½	55 to 56	45 to 46	
March 22	45 to 48	50 to 52½	55 to 56	45 to 46	
March 29	45 to 48	50 to 52½	55 to 56	45 to 46	
April 5	45 to 48	50 to 52½	55 to 56	45 to 46	
April 12	45 to 47	50 to 52½	52 to 55	44 to 46	
April 19	45	48 to 50	52 to 53	44	
April 26	45	48 to 50	52 to 53	44	
May 3	45	48 to 50	52 to 53	44	
May 10	45	48 to 50	52 to 53	44	
May 17	35	42 to 44	46 to 50	46 to 48	
May 24	35	40 to 41	45 to 47½	34 to 35	
May 31	35 to 36	40 to 41	45 to 47½	34 to 35	
June 7	35 to 36	40 to 41	45 to 47½	34 to 35	
June 14	36 to 37	42 to 44	45 to 47½	35	
June 21	38 to 39	44 to 46	45 to 47½	37 to 38	
June 28	35 to 38	44 to 46	45 to 47½	35 to 36	
July 5	35 to 38	44 to 46	45 to 47½	35 to 36	
July 12	36 to 38	44 to 46	45 to 47½	35 to 36	
July 19	35 to 35½		46 to 50	34 to 35	
July 26	33½ to 34		46 to 50	33½ to 33	
August 2	32½ to 33		46 to 50	32	
August 9	33		46 to 50	32	
August 16	33		45 to 47	32	
August 23	33		45	32	
August 30	33 to 34	40	45	33	
September 6	34 to 35	40	45	33	
September 13	34 to 35	40	45	33	
September 20	34 to 35	40	45	33	
September 27	34 to 35	40	45	33	
October 4	35	40	45	33 to 34	
October 11	38 to 40	44	47	36 to 37	35
October 18	42 to 45	46 to 48	48 to 50	38 to 40	35 to 36

Prices current of menhaden oil—Continued.

Date.	Select light.	Select light, strained.	Bleached.	Choice brown.	Inferior to dark.
	Cents per gallon.	Cents per gallon.	Cents per gallon.	Cents per gallon.	Cents per gallon.
1876.					
October 25.....	42 to 45	46 to 48	48 to 50	38 to 40	35 to 36
November 1.....	42 to 43	45 to 46	48 to 50	40	36
November 8.....	40 to 42	45 to 46	48 to 50	38 to 40	36
November 15.....	40 to 42	45 to 46	50 to 52	38 to 40	36
November 22.....	40 to 42	45 to 46	50 to 52	38 to 40	36
November 29.....	40 to 42	45 to 46	50 to 52	38 to 40	36
December 6.....	40 to 42	45 to 46	50 to 52	38 to 40	34 to 36
December 13.....	41 to 42	45 to 46	50 to 52	40	34 to 36
December 20.....	41 to 42	45 to 46	50 to 52	40	34 to 36
December 27.....	41 to 42	45 to 46	50 to 52	40	34 to 36
1877.					
January 3.....	41 to 42	45 to 46	50 to 52	40	34 to 36
January 10.....	42 to 43	45 to 46	50 to 52	40	34 to 36
January 17.....	42 to 45	46 to 48	52	40	34 to 36
January 24.....	42 to 45	46 to 48	52	40	34 to 36
January 31.....	41 to 45	46 to 48	52	40	34 to 36
February 7.....	42 to 45	46 to 48	52	40	34 to 36
February 14.....	40 to 43	45 to 46	52	40 to 41	34 to 36
February 21.....	40 to 42	44 to 45	50 to 52	40 to 41	34 to 36
February 28.....	40 to 42	41 to 45	50 to 52	40 to 41	34 to 36
March 7.....	41 to 42	42 to 44	48 to 50	40	34 to 36
March 14.....	41 to 42	42 to 43	47 to 49	38 to 39	34 to 35
March 21.....	41 to 42	42 to 43	47 to 49	38 to 39	34 to 35
March 28.....	41 to 42	42 to 43	47 to 49	38 to 39	34 to 35
April 4.....	40 to 41	42 to 43	47 to 48	38 to 39	34 to 35
April 11.....	40 to 41	42 to 43	47 to 48	38 to 39	34 to 35
April 18.....	37 to 40	42 to 43	45 to 47	35 to 36	32 to 34
April 25.....	36 to 38	41 to 42	42 to 45	33 to 34	30 to 32
May 2.....	38	42	43 to 46	34 to 36	30 to 32
May 9.....	38	42	43 to 46	36 to 37	32 to 34
May 16.....	38	42	45 to 46	36 to 37	32 to 34
May 23.....	37 to 38	42	45 to 46	36 to 37	32 to 34
May 30.....	36 to 37	42	45 to 46	36	32 to 34
June 6.....	34 to 35	42	45 to 46	34	32 to 34
June 13.....	34 to 35	42	45 to 46	34	32 to 34
June 20.....	34 to 35	38 to 40	45 to 46	34	32 to 34
June 27.....	34 to 35	38 to 40	45 to 46	31	32 to 34
July 4.....	33 to 34	38 to 40	45 to 46	32 to 33	30 to 32
July 11.....	33 to 34	38 to 40	45 to 46	32 to 33	30 to 32
July 18.....	33 to 34	38 to 40	45 to 46	32 to 33	30 to 32
July 25.....	33 to 34	38 to 40	45 to 46	32 to 33	30 to 32
August 1.....	33 to 34	38 to 40	45 to 46	32 to 33	30 to 32
August 8.....	34	38 to 40	45 to 46	33 to 34	30 to 32
August 15.....	36 to 38	38 to 40	45 to 46	36 to 35	34 to 35
August 22.....	36 to 38	38 to 40	45 to 46	35 to 36	34 to 35
August 29.....	38	40 to 42	47 to 48	35 to 36	34 to 35
September 5.....	38	40 to 42	47 to 48	35 to 36	34 to 35
September 12.....	42 to 45	44 to 46	49 to 50	38 to 40	35 to 38
September 19.....	45	44 to 46	50 to 52	42 to 44	40 to 42
September 26.....	45	46 to 47	51 to 52	42 to 44	40 to 42
October 3.....	45	46 to 47	52 to 53	44	40 to 42
October 10.....	45	46 to 47	52 to 53	44	40 to 42
October 17.....	45	46 to 47	52 to 53	44	40 to 42
October 24.....	45 to 46	47 to 48	52 to 53	44	40 to 42
October 31.....	45 to 46	47 to 48	52 to 53	44	40 to 42
November 7.....	45 to 46	47 to 48	52 to 53	44	40 to 42
November 14.....	45	47 to 48	52 to 54	44	40 to 42
November 21.....	45	47 to 48	52 to 54	44 to 44 to 44	40 to 42
November 28.....	45	47 to 48	52 to 54	44 to 44 to 44	40 to 42
December 5.....	45	47 to 48	53 to 54	44 to 44 to 44	40 to 42
December 12.....	46	48 to 50	53 to 54	45 to 45 to 45	40 to 42
December 19.....	46 to 47	48 to 50	52 to 53 to 53	45 to 46	40 to 42
December 26.....	46 to 47	48 to 50	52 to 53 to 53	45 to 46	40 to 42
1878.					
January 2.....	46 to 47	48 to 50	52 to 53 to 53	45 to 46	40 to 42

CURRENT WEEKLY REPORTS OF THE MENHADEN OIL MARKET FROM
1871-1878.

[Compiled from "Oil, Paint, and Drug Reporter," of New York, W. O. Allison, editor.]

1871.**OCTOBER 18.**

Menhaden with many small lots arriving during the latter part of last week reacted from the advanced prices, and some sales were made at a decline of fully 1c. per gallon; the close is, we think, rather more steady, with most of the arrivals bought up. Sales are 68 bbls. prime white, at 41½c.; 112 bbls., at 41c.; 90 bbls., at 40½c.; 110 bbls., at 40c.; 61 bbls. light, at 41c.; 125 bbls., on p. t.; 150 bbls. fair, at 39c.; 50 prime, at 40½c.; 12 bbls. common, at 30c.; 30 bbls. Gurry, at 20 @ 25c.; and 50 bbls. re-pressed choice, at 45 @ 48c.; also 7,000 lbs. foots for export, at 4½c., and 300 tons of guano, at \$15, delivered.

OCTOBER 25, 1871.

Menhaden has been scarce all the week; there has been a demand for more than could be obtained; 250 bbls. sold at the close for export at 41c., and in lots, 300 bbls. for home use, at 41 @ 41½c. for choice light, and 39 @ 40c. for choice brown.

NOVEMBER 1.

Menhaden has been in rather light demand, and with free receipts of choice new fall made prices lower at the close, with several lots offering on the market. The sales are 280 bbls. on private terms; 50 bbls. selected light last week at 42c.; 101 bbls. choice, at 40½c.; 98 do. at 40½c.; 25 bbls. brown, at 39½c.; and a mixed lot of 30 bbls., at 39c.

NOVEMBER 8.

Menhaden has been in steady, fair demand during the past week, and the close is very much higher and somewhat unsettled; 45c. is bid choice. The sales during the past week are as follows: 378 bbls. prime, at 40c.; 150 bbls. good, at 39½c.; 200 bbls. choice, at 40½c.; 100 bbls. to arrive, at 41c.; 150 bbls. at the factory, at 40c.; 75 bbls. for export, at 41c.; 200 bbls., at 41½c.; and 113 bbls., at 40½c.; and 250 bbls. pressed on private terms.

NOVEMBER 15.

Menhaden has been fairly active and more excited than any other kind on our list; prices have advanced, and at the close the tendency is apparently upward, though we hear of one lot of choice offered for sale at 50c. Sales are 150 bbls., at 47½c.; 100 bbls., at 50c.; 190 bbls., at 50c.; 25 bbls. on private terms, and 131 bbls. on private terms.

NOVEMBER 22.

Menhaden has continued to move freely, and prices have still further advanced. If a party wants to buy, 52½c. is the lowest price for a good lot. At the close 100 bbls. on dock were offered at this price, without a

buyer, and will be put in store—50c. was bid. All the sales, however, of prime lots made this week have been at this price. We notice sales of 25 bbls. inferior at 47½c.; 200 bbls. last week, at 50c. or less; 60 bbls. choice, at 52½c.; 100 bbls., at 52½c.; 120 bbls., at 52½c.; 50 bbls. choice, at 52½c., and 100 bbls., at 52½c. Pressed menhaden meets with a good demand; 50 bbls. sold at 60c. Jobbing lots can be sold easily at this price.

NOVEMBER 29.

Menhaden has been more active and rules very strong; at the close 52½c. has been refused, but we hear of no lots from first hands having brought more. The sales of crude are 185 bbls, at 52½c.; 200 bbls., at 52c.; 38 bbls., 27 bbls., 22 bbls., and 25 bbls., at 52½c.; also, 25 bbls. at higher price, not given. Pressed is generally quoted at 60c., though some parties are still offering for less.

DECEMBER 6.

Menhaden has ruled quiet the past week. We know of no actual sale from first hands at more than 52½c., though an outside party is said to have paid 53c.; some of the largest holders are not offering their stock at the present. The sales are in all 250 bbls. on spot at 52½c. and 114 bbls. to arrive at same price. Pressed is held higher, though some parties who had some before the advance are underselling the regular trade.

DECEMBER 13.

Menhaden is very firm. There are few parties willing to sell at less than 55c. A sale was rumored to-day at 54c., but we know of no parties willing to pay more than 52½c.; 100 bbls. sold here at this price, and in Boston 10,000 gallons, for export, at 52½c., and 100 bbls. for home use, at 53½c.

DECEMBER 20.

Menhaden has been very quiet during the past week; dealers are taking all lots that are offering cheap, and prices remain steady, though no full lots of choice have reached our highest quotations. The only sales we hear of are 120 bbls. at 52½ @ 53c., and 77 bbls. on private terms below the market.

DECEMBER 27.

Menhaden has been very quiet; those who hold stock look for full prices, but buyers will not pay the advance for full lots. We hear of no sales. There is a report that some of the menhaden exported is on the way to this market again. We were informed by a party having a large lot in the English market that if it did not improve in price there, he would have his shipped back to this market again; if the oil is on shipboard, this can be done at a small profit, taking the markets as they are quoted at present.

1872.

JANUARY 3.

Menhaden has improved in tone again; buyers have been forced to pay the prices demanded by holders, and the tendency is again upward.

We hear of a sale of 108 bbls. prime light at 55c., and 50 bbls. not sweet at 52½c. There is a good demand for pressed, and the choicest is held at higher prices, with full sales. We note 75 bbls. sold at 65c., 20 bbls. brown at 60c., and a small lot at 58c.

JANUARY 10.

Menhaden oil meets with very little demand; the ideas of holders are above those of buyers, and we have no business to report; there are rumors but no actual sales of full lots that we can learn of. The demand for pressed fish is fair; 25 bbls. brown sold at 60c., and 25 bbls. light at 63c.

JANUARY 17.

Menhaden rules quiet; to sell freely lower prices would have to be accepted, but to buy full prices would have to be paid. No sales of lots are reported.

JANUARY 24.

Menhaden rules about steady, though if forced on the market would not command the highest quotation. The feeling is, however, that the stock is small and all will be needed. We hear of the sale of 50 bbls. prime, at 55c., and 112 bbls. Southern, part dark, at 52c. cash. There is a fair demand for strained and 25 bbls. are reported sold at 63c.

JANUARY 13.

Menhaden is steady in prices, the only large lot held, 600 bbls., was at New Bedford, which has been sold to a manufacturer there at a price equal to 55c., delivered in this city, the lot of Southern reported in our last has been rejected; at the close to-day we hear of the sale of 120 bbls. on private terms. Strained sells in a small way, if choice, at 65c., in full lots at 60 @ 62½c., and brown 60c. in a small way.

FEBRUARY 7.

Menhaden is held confidently, but there is not much doing. We hear of no full lots having changed hands.

FEBRUARY 14.

Menhaden is quiet and there are no sales making; we have only heard during the past week of a few lots, perhaps in all 50 bbls., that changed hands at 55c. The stock is pretty firmly held by a few parties. Pressed oil is in fair demand and firm.

FEBRUARY 21.

Menhaden is dull to buy; the market is firm, but to sell it is weak, though at a decline of 2½ @ 5c. the whole market might be cleared of stock; no sale of lots for a week.

FEBRUARY 28.

Menhaden has ruled quiet during the past week, and as there have been no sales for some time past, the feeling has been hardly so firm; 100 bbls. choice sold at 54c., the other kinds have met with no sales since our last.

MARCH 6.

Menhaden has been quiet for a long time past, and holders appear more anxious to sell. We hear that sales have been made of 300 bbls. prime, on private terms, though understood to be below 54c.

MARCH 13.

Menhaden has been quiet; the dealers are doing very little, and will not buy unless at a decline from former prices. The sales are 120 bbls. light at 53c. We note the arrival of the first lot of the oil returned from the other side, some 8,000 galls; there are about 42,000 galls. more on the way. Pressed fish oil meets with a slow sale.

MARCH 20.

Menhaden has moved a little more freely, but the sellers have been forced to accept lower prices; the close is, however, considered more firm, as the Boston combination may have some effect on this market. The only sale we hear of is a lot of 150 bbls. prime, at 52c. cash. There is a little better demand for pressed, and we note 30 bbls. sold at 60½c., and 50 bbls. at 60c.

MARCH 27.

Menhaden has been bought quite largely during the past week, which has had the effect of advancing prices; the sales are about 550 bbls., at 54 @ 55c., the latter for choice light, though at the close the highest price is said to have been bid for brown. Pressed meets with a fair sale; 2,500 gallons sold at 59 @ 61c., the lowest price for inferior, and 1,500 gallons choice winter at 64c.

APRIL 3.

Menhaden oil remains firm, and 58c. would be low for nice oil; some lots might be obtained at 55c., but it would be off in color. The combination is having some effect, and how long it will last is more than can be predicted.

APRIL 10.

Menhaden is scarce; there was too much shipped, which has left the market bare. Handsome is held at 60c.

APRIL 17.

Menhaden is firmer, and with the failure of the seal-fishery all grades of fish-oil will be in demand at advanced rates; 60c. for clean, handsome parcels might be obtained, and some ask an advance on this price.

APRIL 24.

Menhaden is quiet but firm; the principal holder asks 65c., but some others are quoting 62c. There have been no sales, but in New Bedford 400 bbls. sold to go to Boston, at 60c.

MAY 1.

Menhaden remains scarce & firm, 60 @ 62c. for handsome. There was too much shipped.

MAY 8.

Menhaden, as reported at the date of our last, is weak. We reported the market "less buoyant" last week and quoted choice at 60 @ 62c. in

our prices current. We have been accused "bearing" the market on that occasion, but we think our accuser could not have been posted, for the very choicest lots in market were offered the day of our issue at 60c., and not being able to get that price, asked for a bid of 59c. We have heard of no sales.

MAY 15.

Menhaden is quiet, and the feeling is easy; holders do not force sales, but are open for offers; buyers are generally very backward. The sales reported are 150 bbls. in New Bedford, and 40 bbls. here at 60c., though other choice lots are offered freely at this price. There have been sales of pressed at 62c.

MAY 22.

Menhaden is unsettled and lower. No one quotes higher than 57½c., and no one will bid 55c. There is considerable offering. We hear of no sales of lots since our last.

MAY 29.

Menhaden oil of the new catch is arriving more freely, and prices are lower at the close, with buyers holding off. There have been sales of 150 bbls. new at about 50c., but at the close we do not think that more than 47½c. could be obtained; thus far the oil we have seen is of very good quality, and not inferior, as some parties anticipated it would be.

JUNE 5.

Menhaden oil is lower; the receipts are quite free, and the tendency of prices have been steadily downward; the quality coming to this market has been very good for the first part of the season. The sales are 50 bbls. at 47c.; 43 bbls. at 45c., prompt cash; 60 bbls. at 45c.; 45 bbls. at 44½c., and 50 bbls. at 44c., at which the market closes not very strong; inferior was offered and refused at 40c.

JUNE 12.

Menhaden oil; nothing has been done in Maine as yet.

JUNE 19.

Menhaden, following our last, was in active request for Boston account, and, to some extent, for shipment, which took about all the surplus offerings and checked the downward tendency, and a firm tone now prevails. The fishermen are holding back as much as possible, and toward the close the run of fish is falling off. They also say that at 40c. per gallon, delivered in this market, there is no margin for making oil. The sales are 200 bbls. at 38c.; 600 bbls. at 39 @ 40c.; 200 bbls. at 40c.; 48 bbls. at 40 @ 40½c., and 75 bbls. taken to account at 40c.

JUNE 26.

Menhaden has been less plenty this week than last, and receivers have been able to get an advance on prime lots of 1 cent per gallon, and the close is steady at 41 cents. From Maine we hear that fish are very scarce, and that the Boston trade are likely to draw on this market for their supply for some time yet; besides, the fishermen, we believe, entered last fall into an arrangement not to sell below 60c. till the 15th of July.

JULY 3.

Menhaden has suddenly become scarce, and with some dealers short; the price has advanced as rapidly again as it declined. At the close we hear of one lot, about 45 bbls. light, offering, on which 47c. is said to have been bid and refused; the holder asks 48c. If any lots should be offered, this price could not be obtained, as shippers cannot pay more than 41c. We learn from Maine that the fish are more abundant, but do not yield largely.

JULY 10.

The market for menhaden has ruled quite irregular since our last; the arrivals at the close, however, are more free and prices are lower, but more uniform. There have been some lots taken for shipment, and the low prices ruling a short time ago will hardly again be reached. The sales are 142 bbls. prime at 43c.; 200 bbls. at 41½c.; and 450 bbls., part for shipment, on private terms, though some at considerably above the prices obtained for the above lots. There is a fair trade for pressed at 48c.

JULY 17.

The market for menhaden at the close is firm, owing to light arrivals this week. The trade talk a small catch, and say prices will probably rule higher. Last week there were sales of 200 bbls. at 43½c. for prime and 42c. for inferior, and 70 bbls. prime light at 44 @ 45c. The demand for strained is fair.

JULY 24.

Menhaden has been in rather moderate supply during the past week, and prices rule firm. At the close the advices from the fishermen are that they are catching more fish, and the yield is good. We note sales of 65 bbls. choice light at 43 c., and 50 bbls. brown at 40c.

JULY 31.

There has been more activity in menhaden than any other kind of oil on our list. The amount coming forward is small, and barely enough to supply the wants of the trade, causing prices again to advance. Heretofore the yield of the fish has been very small, but at the close to-day we hear that the run has suddenly become fat, and above an ordinary yield is now obtained. The sales are 104 bbls. choice brown at 46c.; 50 bbls. do. at 46c.; 40 bbls. racked at 46c.; 20 bbls. gurry at 25c.; 25 bbls. strictly winter pressed at 55c.; and a rumor, which, however, was not confirmed, of a lot of choice crude at 47c.

AUGUST 7.

Menhaden this week has been in better supply, and is quoted very much lower at the close. The catch is better and the yield fair for this season of the year; receipts since our last have been about 200 bbls., which sold at from 43c. for nice brown to 46c. for choice light; at the close we hear that a lot of 400 bbls. prime brown was offered, to arrive, at 43c.

AUGUST 14.

The market for menhaden has been quiet, and with dealers less anxious to buy; the close is easy at about 43c. for light brown. The high prices for freights will not allow of any shipping business at present ruling quotations. The sales reported for the week are 417 bbls. at 43 @ 44c., including a resale of 75 bbls. at the outside price; 200 bbls. to arrive at 42c., and a lot of 250 bbls. choice light in New Bedford some time since, not before reported, at 45c.

AUGUST 21.

Menhaden at the moment is scarce; there are orders here at 43c., but there is no stock to fill them; considerable lots are reported on the way, and this keeps prices from advancing materially, though we may quote at least 1c. better as the outside price.

AUGUST 28.

Menhaden oil remains as last reported. Prices are above views of buyers, but the manufacturers will not yield, and the result is that the oil will pass into parties' hands that will make advances on the oil. This locks the oil for the present.

SEPTEMBER 4.

Menhaden has not been plenty since our last, and a rather firmer tone is reported at the close. We hear of the arrival of a lot of 275 bbls. and of about 750 bbls. more on the way. The sales are 400 bbls., part to arrive, at 44c. for choice light, and 75 bbls., at 43c. for brown, and 40c. for inferior. The fishermen report a fair catch, and we hear that the yield is increasing both here and in Maine.

SEPTEMBER 11.

Menhaden is firm at the close, with moderate offerings. Last week the receipts were full, but were readily taken at steady prices. This week there have been no arrivals, and the tone firmer; probably 45c. could be obtained for a choice lot. The sales reported since our last are 300 bbls., at 44c.; 75 bbls., at 44c.; 168 bbls., at 43½ @ 44c.; 90 choice and 70 do., at 44½c.

SEPTEMBER 18.

Menhaden rules firm, with a small amount arriving; sales 250 bbls. fair brown, at 44c.; 115 bbls. on private terms; 36 bbls. choice light, at 47c., and 100 choice tanked, at 48c.; also a rumor of 1,000 in New Bedford, at 50c.

SEPTEMBER 25.

Menhaden has advanced since our last about 4c. per gallon, owing to the small supply offering on the market. Sales have been made of 150 bbls., at 49 @ 50c. for light brown and choice; 38 bbls. brown, at 49c.; 30 bbls. and 50 bbls., at 50c., at which the market closes strong, with exporters willing to pay this price.

OCTOBER 2.

Menhaden oil has not arrived freely, and the price is rather stronger. Since our last, sales have been made of 150 bbls., at 50c., and to-day a

cargo arrived, and about 350 bbls. sold, at 50c., as it run, and a lot of 39 bbls. brown, at 50c., which is the price for any kind of good oil.

OCTOBER 9.

Menhaden has been quite active, and rules very firm; sales are 80 bbls. prime at 50c.; 82 bbls. at 52c.; 170 bbls. at 50½c.; 150 bbls., to arrive, at 50 @ 50½c.; and 425 bbls. on private terms. Most of the above lots were very choice light oils.

OCTOBER 16.

Menhaden has not come in so freely, still there is rather more offering, and buyers are holding off, and some report the market lower. There is some Maine offering, but we know of 48c. having been refused for it. We only note the sales during the week of 100 bbls. prime light at 50c., and 150 bbls. fair brown at 45c. The fall catch is reported better.

OCTOBER 23.

Menhaden rules steady for light oil, and all that has come forward has been taken at 50c.; we note sales of 159 bbls. at this price; 100 bbls. Maine oil at 52½c.; 100 bbls. do. at 53½c.; 100 bbls. pressed at 55c., and 30 bbls. do. at 57c.

OCTOBER 30.

Menhaden is a little easier, though in good demand; sales are 189 bbls. prime at 49c.; 150 bbls. at 49c.; 100 bbls. at 50c., thirty days; 100 bbls. at 50c., cash; and 55 bbls. at 50c. cash.

NOVEMBER 6.

Menhaden has ruled quiet but firm, with but few lots arriving. The only sales since our last are 100 bbls. at 50c. and 90 bbls. at 49c.

NOVEMBER 13.

Menhaden is not arriving freely, and the market is very strong, with all the good oil that is offered taken at 49c., though most holders ask 50c. Sales are 278 bbls. at 49c.

NOVEMBER 20.

Menhaden is higher, with sales at an advance; the market is, however, somewhat unsettled. The stock in Boston, about 8,000 bbls., was burnt. Sales 280 bbls. and 100 bbls. on p. t., and last week 75 bbls. at 50½c.

NOVEMBER 27.

Menhaden oil has been actively dealt in, closing firm at an advance. The sales and resales have been fully 2,000 bbls. from 51c. up to 55c., which latter price is said to have been bid at the close for light oil and refused.

DECEMBER 4.

Menhaden has continued firm and is quiet. The stock is now pretty well out of first hands. Sales of 140 bbls. at 44c., and 600 bbls. at 55c.

DECEMBER 11.

Menhaden is quiet and a little unsettled; the supply in first hands very light, but jobbers report trade very dull, and a full supply on hand.

DECEMBER 18.

Menhaden has been quiet, owing to small offerings; sales are 30 bbls. prime light at 56c., and 70 bbls. on private terms.

DECEMBER 25.

Menhaden quiet but steady, with a small supply.

1873.

JANUARY 1.

Menhaden quiet, with only small sales making.

JANUARY 8.

Menhaden is firmer, and other oils used by tanners have also advanced.

JANUARY 15.

Menhaden oil rules quiet, and with a small stock very firm in price. We note sales of 120 bbls. from store, reported at 56c.

JANUARY 22.

Menhaden is quiet but very firm; no sales making.

JANUARY 29.

"Menhaden oil: some sales have been made at 57 to 58." (Boston oil-market reports.)

FEBRUARY 5.

Menhaden rules firm, though somewhat nominal, owing to the very small stock.

FEBRUARY 12.

Menhaden oil was active last week, and sales were made of 1,750 bbls. Maine oil, all reported at 60c.

FEBRUARY 19.

Menhaden oil is in small supply in first hands, but dealers hold a pretty fair stock.

FEBRUARY 26.

Menhaden is held very firmly, as there is a very small stock here. Brown oil will bring about as much as light, owing to the small supply.

MARCH 5.

Menhaden is firm, but very quiet; no sales reported.

MARCH 12.

Menhaden is firm, but not active; 100 bbls. Maine oil sold at 60c.

MARCH 19.

Menhaden oil rules quiet; there are some lots offering, to arrive, at 60c., for Maine catch.

MARCH 26.

Menhaden oil has ruled dull since our last offering at 60c. for Maine oil.

APRIL 2.

Menhaden oil rules quiet, but is held higher; no sales making.

APRIL 9.

Menhaden oil rules dull, and lots are pressing for sale; 60c. is asked, but a full lot could not be placed except at a much lower price; we have not a single transaction to note.

APRIL 16.

Menhaden is held at 60c., and not offered at less; but buyers would not buy any lots at anywhere near this price.

APRIL 23.

Menhaden oil nominal; no sales making.

APRIL 30.

Menhaden oil is easier, offering at 57½c. in lots for Maine catch. Sales are 300 bbls.; closing sale at this price.

MAY 7.

Menhaden oil is lower owing to the near approach of the fishing season, and sales have been made of 155 bbls., at 55c.; 25 bbls., at 56c.; and in Boston, 30 bbls., at 56c., and 80 bbls., at 57c.

MAY 14.

Menhaden oil is somewhat nominal, about all in the market having gone into second hands. Jobbers are said to have a smaller supply than usual at this season of the year, and the feeling may be considered a little stronger at the close, owing to the backwardness of the catch. There has been one small lot of inferior now in market from Florida, which has been sold at 50c. The Long Island fishermen report fish scarce and yielding only about one gallon per thousand. If the weather continues fine a few small lots may be expected next week, but not in sufficient quantities to supply the demand for some time. The prospect as to future prices is that the market, without any disturbing influences and a usual catch, will rule at about 42½c. The sales reported since our last are 500 bbls. prime Maine, at 55c., 50 bbls. ordinary, at 57c., and 11 bbls. inferior new Southern, at 50c.

MAY 21.

Menhaden oil has been in fair demand; it is said that the dealers have a small stock on hand. New oil has not yet arrived, but is daily expected. We note sales of 204 bbls. ordinary, at 55c., and 30 bbls. select, at 56c. From Boston reports we have:

"Menhaden oil remains quiet. Sales have been made at 55 and some lots of dark oil have sold at 50. As the season is approaching when new oil will soon make its appearance, those holding old oil are anxious to dispose of their stocks, and under such circumstances sales have been made below market value."

MAY 28.

Menhaden oil rules firm and in small supply. There is said to be no oil in first hands, while usually there is a good deal carried over. New has not made its appearance, but is daily expected. Since our last there has been but one sale, a lot of 110 bbls. at 55c.

JUNE 4.

New menhaden oil is arriving feebly, and the quality not being very choice, prices are lower. The sales are 25 bbls. at 52c.; 25 bbls. at

51c.; and 27 bbls. on private terms. The fishermen report plenty fish but a small yield of oil. Boston, June 2d, reports say:

"Menhaden oil remaining quiet; most of the old oil has been sold at 52 @ 53. The prospect for this season's catch can only be judged by the preparations made for doing the business, all of which are being carried forward on an extensive sale."

JUNE 11.

New menhaden has come to hand very slowly, and the market has not declined materially since our last report. We would quote 51@ 53c., with sales of 50 bbls. choice at 52c., and 50 bbls at 51@ 52c. Jobbing sales at 53c.

JUNE 18.

Menhaden oil comes to hand very slowly, the fish being scarce and yielding only about $1\frac{1}{2}$ gallons per thousand; prices remain firm, with sales of 100 bbls. at 51c. for choice brown, and 52c. for select light; there is but little dark oil coming in and would bring 50c.

JUNE 25.

Menhaden is still in light supply and is consequently held firmly; the fish yield rather poorly but are more plenty and are growing fatter. Sales are 75 bbls. light, 25 bbls do.; 11 bbls. do., at 51c., and 20 bbls. brown at 50c. Boston reports, June 23, 1873, say:

"Menhaden oil of this season's catch has not yet made its appearance, and report says that there are plenty of fish on the coast of Maine, but the yield of oil very small; but with good weather the fish will soon be in good condition. Prospect is that we shall not want for menhaden this season."

JULY 2.

Menhaden oil is about 1c. lower at the close, though receipts are not large. We note sales of 150 bbls. at 50c., 51c. for choice, and 20 bbls. inferior at 48c.

JULY 9.

Menhaden is now coming in more freely and has fallen off in value; last week sale was made of 300 bbls. at 50 @ 51c.; but yesterday and to-day 150 bbls. were sold at 45 @ 47c.

JULY 16.

Menhaden oil has up to last week come to hand very sparingly, and the price was held up till toward the close at 45c.; but with more lots pressing in, sales were made of 52 bbls. at 45c.; 33 bbls. at 43 $\frac{1}{2}$ c., and this week 300 bbls. at 42 $\frac{1}{2}$ c., at which price the market closed.

JULY 23.

Menhaden oil has not come in freely, but buyers are holding off, as the market for their product is dull, and in consequence the price is easier; last week a lot of 50 bbls. sold at 42, but yesterday 38 bbls. sold at 41, and to-day 50 bbls. at 41c., at which the market seems to be steady, as 40c. has been bid and refused, though should receipts be large a further decline may be looked for.

JULY 30.

Menhaden oil rules steady at 40c., with not much coming in. The increased facilities which the fishermen have this season have been of little account thus far, the oil made being less than at the same time last year; still the fish yield fairly, and if they were abundant the production would be very large. Dealers have bought very sparingly, as their trade has been small, and the price has steadily declined since the new oil made its appearance. Exporters could afford to pay the present price if freights were not so unusually high, and with lower freight-rates a good demand may be looked for from this source. How much the large seal catch will interfere with a market for this oil is not known yet, but should the catch of menhaden be large, oil would have to sell at such a price as would be paid by a foreign market. At what price our home dealers would be willing to stock up it is difficult to tell, they having different views as to future prices; but at the present all buy only sufficient to supply their present wants. Sales are 300 bbls. at 40@41c., the highest price last week.

AUGUST 6.

Menhaden oil has not come in very freely; all told, perhaps 400 lbs. for the week, 200 of which sold for home use on private terms, and the balance shipped.

The price remains steady at 40 @ 41c., and there is a difference of opinion as to whether the oil is held back or whether the factories are making but little; most of the trade are of the former opinion. Boston reports, Aug. 4, says: "Menhaden oil: some sales have been made at 45c. for small lots, but the Maine manufacturers are firm and intend putting their price at 50c., and holding. Reports are conflicting in relation to the catch; do not think from all accounts that there will be as much oil as last year."

AUGUST 13.

Menhaden oil has not arrived freely, and is, consequently, a trifle firmer; the catch of fish is unusually small and the yield is only one and a half gallons per thousand. There have been sales here of 600 bbls. at 40 @ 41½c. as to quality, the market closing pretty strong at 41c. for nice oil. The Boston market is higher. Boston reports, Aug. 11, say: "Menhaden oil: there has been a sale of 500 bbls. at 45c., and the manufacturers have agreed to hold price at 50. Most of the Maine oil is being shipped to New Bedford, and parties make advances, which satisfies the manufacturers. By this means they will keep oil up to 50c."

AUGUST 20.

Menhaden oil is firmer, owing to small arrivals and a light stock in the hands of jobbers. The combination in the East also has a tendency to stiffen prices here. The fish are now reported very fat, yielding 10 to 12 gallons per thousand, but the catch is small. Sales 250 bbls. at 41½c. At the close there is none offering on spot, and one lot to arrive

is held as high as 45c., but this may be considered an extreme price; probably 42½c. is a fair quotation for choice oil.

AUGUST 27.

Menhaden has sustained the advance of last week and rules very firm. There is not much coming in, and jobbers carry small stocks, but a better supply may come in at any moment; and, in consequence, jobbers will not buy more at present rates than they require for immediate wants. Sales are 30 bbls. nice brown at 45c.; 50 bbls. choice light at 45c., and 150 bbls. on private terms, supposed to have been about 45c., at which the market closes.

SEPTEMBER 3.

Menhaden oil is very firm, with a small supply coming forward. All lots are taken as fast as they arrive. Sales are 65 barrels at 45c.; 40 barrels inferior on private terms; 31 barrels prime at 45c.; 25 barrels at 45 cents, and 35 bbls. to arrive at 45c. Boston reports, Aug. 25: "Menhaden oil remains firm, and sales of 300 barrels have been made at 48, and it is doubtful if any can be had now less than combination price, 50 cents. The weather has been very unfavorable for 10 days past, and the catch very light. The amount of oil taken this season only amounts to about 6,500 barrels, and the expense has been much greater this season, as the fish are some twenty miles away. The quality of the oil taken is very choice." Sep. 1st: "Menhaden: a sale of 700 bbls. prime Maine has been made at 48c. To-day a meeting is to be held, and price of manufactures will be put at 50 to 52c., and some say 55c. The catch for the past ten days has been very light. Some manufacturers are holding at 55c. Should two thousand bbls. be shipped, it would advance oil to 50c. firm. Five hundred bbls. are going this week from here to Liverpool, and I hear of other lots to follow."

SEPTEMBER 10.

Menhaden has been more plenty the past week, but is taken freely on arrival at firm prices, the jobbers being short supplied and having a good demand for their kinds from consumers. The sales are 495 bbls. at 45c. cash from dock, and would probably bring 46c. in shipping order; but we cannot expect any export demand at present prices for oil, unless freights and exchange should very much favor shippers. There have been two lots sent from this market this season—one of 190 bbls. on order and one of 100 bbls. on account of a factory. The season thus far has been an unsatisfactory one for those who usually supply this market, and should the fall catch not prove better, we will have to look to Maine for a supply for this market. The fall season is, however, often the best, the fish being usually very fat, and if they catch enough fish may make up for all deficiencies; the fall catch last year was small, however.

Boston reports, Sep. 8: "Menhaden continues firm. The manufacturers hold at 50c., but I do not know of any sales at that price; 48c. is the

highest that any large lots have been sold for. The catch is reported light for the past week.

SEPTEMBER 17.

Menhaden oil is firm and wanted, meeting with a ready sale at 45c. for nice brown or light oil. The fall catch cannot be determined yet, but we hear that the fish are said to be wild and do not school; a few weeks, however, will determine the fall catch. Sales here: 95 bbls. light oil at 45c.; 50 bbls. brown at 45c.; 35 bbls. light at 45c.; 40 bbls. at 45c.

SEPTEMBER 24.

Menhaden oil has arrived slowly, and is still firm in price; but with the present uncertain state of the money market and foreign exchange a reaction may take place, as anywhere near present rates there could be nothing done for export. The arrivals and sales have been 30 bbls. at 47c.; 120 bbls. at 45c.; 25 bbls. at 45c.; and 22 bbls. at 45c., which price is not to be obtained at the close, and 400 bbls. have gone into store. Jobbers of curriers' oils report rather less doing this week. Boston reports, Sep. 22: "Menhaden oil is held firm at 48 to 50, but no sales have been made over 48. The exportations still continue; 500 bbls. go to Liverpool this week."

OCTOBER 1.

Menhaden oil is dull and nominal; there have been fewer arrivals, all of which have, however, gone into store, as there are no buyers at more than 42c., while holders still ask 45c., though would probably shade this price for a cash offer. Boston reports, Sep. 29: "Menhaden oil: sales of several lots of 300 to 500 bbls. at 47 to 48c. and holders are now very firm. The catch for the past fifteen days has been better and fish fatter.

OCTOBER 8.

Menhaden oil is not coming forward, and the lots in store have not been sold. The market is nominally as quoted in our list. Sales of 21 barrels on private terms and a report of 75 bbls. for export at 42c., but we were not able to verify the report.

OCTOBER 15.

Menhaden oil is not coming in very freely, but the continued dull state of the market has caused a decline in prices, and at the close 40c. is the best price to be obtained. The home trade are not in the market at all. The sales are, 50 bbls. at 42c.; 56 bbls supposed to be at 41½c.; and 360 bbls. at 40 c., all prime lots, the latter for export. We learn that the Maine fishermen have closed their factories for the season.

OCTOBER 22.

Menhaden oil is very dull and not coming forward; only 22 bbls. have arrived, which sold at 40c.

OCTOBER 29.

Menhaden oil has not arrived freely, but with little or no demand the price has fallen off, and sales have been made of 46 bbls. at 38c., with more offering at the close at same price and buyers bidding 35c. This

evening we hear that 100 bbls. sold at 37½c. and 100 bbls. on private terms.

NOVEMBER 5.

Menhaden oil is very dull, and with none coming in we have no further sales to report; a lot on the way is offering at 37c.

NOVEMBER 12.

Menhaden oil is lower, but the lots that arrived recently have been generally stored, and there is nothing offering at the close at less than 35c., though a prime lot was offered at 33c. on dock, without finding a buyer.

A small lot of Southern oil of inferior quality sold at 30c.

NOVEMBER 19.

Mendahen oil is not lower than we quoted last week, but there is not much doing; jobbers are buying very sparingly, and there is not, as yet, much demand for shipment, but while the present demand from jobbers does not warrant stocking up, the unusually low price may induce them to anticipate their wants. There have been sales of 10,000 gallons for export at 32c., and 200 bbls. for home use at 33c.

Boston reports, Nov. 17: "Menhaden oil is held above the views of buyers. It is difficult to give the quotation in the absence of any sales of importance; last sale was about 38 for 250 bbls."

NOVEMBER 26.

Menhaden oil is quiet, but with no lots coming in the price is rather more steady, with sales of 100 bbls. light at 33c.; most holders ask 35c. from store. Brwon oil not being plenty this season will bring about as much as light. Boston reports, Nov. 24: Menhaden oil held above the views of buyers. It would be difficult to get an offer of more than 37 to 38c., and most of the holders will sell less than 42 to 40c.

DECEMBER 3.

Menhaden oil has become very much firmer, all the lots pressing for sale having been taken; holders ask 40c. The last sale was 150 bbls. prime light at 35c.; previously there was a sale of 100 bbls. at 34½c., prompt cash. It is difficult to give an exact quotation, but the probability is that no great quantity could be bought under 40c. Any action taken by the Maine fishermen, who meet in Boston to-day, may have some influence. Boston reports, Dec. 1: "Menhaden oil: the difference between the buyers and sellers still exists, and as curriers are not running on full time, not much oil changes hands. The manufacturers meet in this city Tuesday, December 2. Some agreement may be adopted in relation to prices for oil on hand and also that to be made the coming season.

DECEMBER 10.

Menhaden oil has advanced, closing firm at the asking price of last week, with considerable sales making. There are free buyers at prices

a shade below the asking rates, but holders are not shading 40c. on any lot, and most of them ask 45c. The Eastern manufacturers have combined at 45c., and this lends strength to our market. While the amount of oil held back by the manufacturers is thought to be considerable, and the demand from dealers been small, still there is a feeling that prices are low and likely to advance. The sales are 310 bbls. on spot, at 40c. Boston reports, Dec. 8th: "Menhaden is firmer and sales have been made of about 1,500 bbls. at 40 @ 41c.; it is now held at 43 @ 45c. The meeting of the oil manufacturers last Tuesday resulted in holding oil at 45, which they seem determined to carry out. There is to be another meeting next January in New York for the purpose of effecting a union with the Long Island and New Jersey associations, and making a uniform price among the different cities."

DECEMBER 17.

Menhaden oil has been more active, and 325 bbls. sold on spot here at 40c., and 800 bbls. to arrive on private terms. Boston reports, Dec. 15: "Menhaden remains firm, and sales have been made at 40c. for several hundred bbls. which have been floating about the market. When these lots are closed out it will be difficult to buy under 45c., a price at which it is held. A sale is reported of 500 bbls. at 42½c."

DECEMBER 24.

Boston reports, Dec. 22: "Menhaden-oil maintains its firmness, but not many sales have been made. Sellers are holding at 45c., which is above buyers' views."

DECEMBER 31.

Menhaden oil is not active, but remains firm in price, with not much coming forward. What action the fishermen may take at their meeting next week is not known, but the effect is certainly depressing. There have been sales since our last of 200 bbls at 40c., and to-day 80 bbls. at 40c. Boston reports: Dec. 29th, "Menhaden quiet; there does not seem to be any inclination on the part of buyers to pay the prices asked by sellers, and with the close of the year parties have no disposition to increase stocks. Sales have been very limited."

1874.

JANUARY 7.

Menhaden oil is quiet, but steady. Arrivals light. Last sale 140 bbls., at 41c.

JANUARY 14.

Menhaden oil is higher since the meeting of the manufacturers last Wednesday, and there are buyers at 42½c., and it is rumored that 43c. has been bid. There have been other sales than those we report, but they are for the present kept private; we note 175 bbls. on private terms; 100 bbls., at 42½c.; 50 bbls., at 42½c.; 4,000 gallons in Boston, and 50 bbls. pressed oil here, on private terms.

JANUARY 21.

Menhaden oil is higher and in more demand, but the advance checks sales for the moment. There are no lots to be had for less than 45c., with 44½c. bid and refused. There was a sale last Wednesday of 150 bbls. for export at 43c., and since 50 bbls. for home use at 44c., and 10,000 gallons in casks to arrive at 42½c.

JANUARY 28.

Menhaden oil has not been so active the past week, buyers and sellers being apart in their views; sales are 300 bbls., at 44c.

There are several lots offering at 45c., and buyers have bid 44c.

FEBRUARY 4.

Menhaden oil has been in good demand, and the market is very firm, with an upward tendency. There have been considerable sales during the past week, part said to be for export. We note the following lots sold: 1,500 bbls. Maine oil to come here; 1,500 bbls. to an Eastern manufacturer; 1,542 bbls. and 50 casks other kinds; and 400 bbls. direct from manufacturers are reported at 45c. The market closes at 45c. bid, and 47½c. asked.

Boston reports Feb. 2d: "Menhaden oil nearly all in first hands has been closed out at 42½ to 43c.; some are holding at 45c., but it does not find ready sale at this price."

FEBRUARY 11.

Menhaden oil has ruled quiet but firm, 45c. having been bid and refused; 47½c. is asked. Sales since our last, 382 bbls. at 45c. Boston reports Feb. 9: "Menhaden oil has been sold at 42 to 44c., and only a small quantity remains in first hands that is held at 45c."

FEBRUARY 18.

Menhaden oil has ruled quiet the past week, but is very firm in price, 46c. having been bid for shipment. The sales are 300 bbls. for home use, at 47½c. Boston reports, Feb. 16th: "Menhaden—a sale of 700 bbls. has been made on private terms; the curriers are not doing much, so the demand for fish-oils is very light, and prices are no higher than last week."

FEBRUARY 25.

Menhaden oil quiet and hardly so firm; 100 bbls. reported sold from a dealer's hands, at 47½c.; 50 bbls. from dock at 45c., and to-day a lot was offered on dock at 46c., but was not sold up to a late hour this afternoon.

MARCH 4.

Menhaden oil is quiet, and with a light jobbing demand, and dealers well stocked up, the tone is not strong. Sales of 50 bbls. for export on private terms, and 60 for home use at 45c., at which price there are other buyers.

MARCH 11.

Menhaden oil is dull, and but few sales are making; some lots arriving have been stored, as holders will not submit to any concession in

price. Buyers are all supplied for the moment, and will not pay 45c. Sales are 50 bbls. on private terms. Boston reports, March 9: "Menhaden oil is quiet, not much offering; it is held at 45c., but buyers do not seem to think they can pay it. Curriers remain inactive, hence demand for oil is very light."

MARCH 18.

Menhaden oil is lower, as some small lots continue to arrive, and are pressed for sale, the larger dealers being all stocked up for the present, and complain of dull trade. Holders generally look for better prices, and refuse to sell at less than 45c. There has been a sale of 170 bbls. for shipment at 42c., and there are some other lots said to be offering at this price to arrive. Boston reports, March 16th: "Menhaden oil is held at 45c. for choice; some lots a little below standard have been shaded; with only about 1,000 bbls. in first hands, if there is any business this spring oil must advance."

MARCH 25.

Menhaden oil has arrived very sparingly, and we have heard of no sales since our last; 45c. is asked, but buyers would not pay more than 43c.

APRIL 1.

Menhaden oil is very dull. There have been no arrivals, but it would have been difficult to place any quantity even at our lowest price. The only sale we hear of is 50 bbls. prime from second hands at 45c.

APRIL 8.

Menhaden oil dull; no arrivals, but the market is weak, and 41c. will now buy a small lot here.

APRIL 15.

Menhaden oil has been slow of sale, with some arrivals of Maine lots on this market. There are sales of some considerable lots, reported chiefly on private terms, some of which have been held here for some time. The sales foot up 1,255 bbls., part at 41c. for prime, up to 42½c. @ 43c. for Maine, and a resale of same at 44c. About half of these sales were for export, the advance in gold assisting this trade.

APRIL 22.

Menhaden oil is dull, and can be had at 41c., but there have been no sales of prime from first hands. Maine oil is held at 42c. Boston reports April 20: "Menhaden oil continues dull, and without any demand it is difficult to fix a price. There is oil going to be exported, and if the surplus should be sent away prices will be firmer and higher."

APRIL 29.

Menhaden oil is still very quiet, and we have only 250 bbls. to report sold at 41c. Boston reports, April 27th: "Menhaden oil quiet, and, as there has not been any large sales made, we cannot give price, but it looks as though it would be higher."

MAY 6.

Menhaden oil has been more active, holders meeting the views of buyers, with the approach of warm weather and the fishing season. Sales are 250 bbls. for export at 41c.; 400 bbls. for home use at 40c.; and 700 bbls. for home use on private terms. Boston reports, May 4th: "Menhaden—a sale of 400 bbls. for export was made at 40c., but it is held higher at close. The news from the seal fishery is of a very discouraging nature, and the first news is more than verified. This must advance menhaden and whale oils."

MAY 13.

Menhaden oil has been quiet, with small offerings recently. There has been some inquiry at late prices, but the only lots coming forward since our last have been small inferior ones, and sold at irregular prices; the new catch has been fair for so early in the season.

MAY 20.

Menhaden oil has ruled quiet with small arrivals. Prices have not improved. One lot of 175 bbls. came in during the week, and sold for shipment at 40½c., at which price there are buyers for export. The new catch is reported as very favorable, but none has as yet made its appearance in market. Pressed fish, sold to the extent of 50 bbls. at 44c. Strained choice menhaden oil is in some demand, and 25 bbls. sold at 47c.

MAY 27.

Menhaden oil is quiet; there is not much coming forward, but dealers will buy only such lots as they actually need. The new catch has been reported less favorable the past week on account of the cold and stormy weather. Sales are reported of 50 bbls. new oil, the first of the season at 40c., and 160 bbls. old at 40c. Boston reports, May 25th: "Menhaden oil dull, and not much demand for home consumption; several lots have been shipped at about 40c."

JUNE 3.

Menhaden oil is beginning to come forward more freely; but holders have not as yet offered below 40c., and one lot of 50 bbls. is reported at that price. The new catch is reported as more favorable than any preceding year at this time, but manufacturers say it will not pay to make at much below present prices.

JUNE 10.

Menhaden has been offering freely, and some lots have been pressed for sale from dock, and low prices have been named on them. Buyers will not take hold except as they need for actual wants, and prices are low, without much business. Sales, 75 bbls. on private terms, and some small parcels at 37 @ 38c. from dock. There has been some inquiry for pressed for export, and 125 bbls. sold at 46c.

JUNE 17.

Menhaden oil is coming to hand freely and has to be sold at prices which exporters are willing to pay; there have been sales of 125 bbls.

at 38c. and 500 bbls. for export on private terms. The fishing is said to be very favorable and the make large. Boston reports, June 15th: "Menhaden oil, small sales at 40c. The demand is light, as curriers are doing comparatively nothing. The eastern manufacturers are making preparations for doing a large business, and intend commencing in a few days if the fish should arrive."

JUNE 24.

Menhaden has been offered freely and closes easy, though there are buyers for export at better than the lowest price, which was a lot of 140 bbls. prime, at 35c. The market closes, we think, at about 36c. There is a fair demand for pressed oil.

JULY 1.

Menhaden oil has not come to hand quite so freely of late, and buyers begin to think that better prices may rule. There have been sales of 550 bbls. at 35 @ 36c., part at the latter price was for export, and we would quote the market firm at the close at 36c. and some of the fishermen asking higher prices. Boston reports, June 22d: "Menhaden oil—Some 400 bbls., all that remains of last season's catch on the coast of Maine has been shipped to Liverpool during the past week. There have been no sales of new oil; prices asked are 37 @ 38c. The weather has been such as to prevent taking any fish the past week. All are anxiously looking to the Maine fisheries for a supply of oil, which have failed them from seal fisheries and cotton-seed." Boston reports, June 29th: "Menhaden oil—The catch of fish has commenced on the coast of Maine, but the quality is such that the yield of oil is small. The expense of manufacturing oil is so great that, unless oil should bring 40c. or upward, it will be unremunerative to the makers of oil."

JULY 8.

Menhaden oil continued to increase in firmness following the date of our last report, and sales have been made of fully 1,000 barrels chiefly at 37c., and largely for export. Many of the fishermen are asking 40c., and are not offering to sell at less; if the receipts increase this week again the price will probably decline, but should they continue to be only moderate 40c. would probably be reached.

JULY 15.

Menhaden oil has come forward a little more freely, and as the demand is not urgent for either home use or export prices are a trifle easier. There have been sales of 150 bbls. for export at 36c. At the close 36c. is asked and 35c. has been bid, and sales made of 123 bbls. for home use at 35c. Boston, reports July 13th: "Menhaden oil—There has been a sale of 1,000 bbls. at 38 @. 39c. of this year's catch, but at the close fishermen are asking 40c. The weather has been very unfavorable the past week, and should it continue it will have a tendency to advance the price of oil. Much depends upon the results of the fishing for the next three weeks. The cost of oil has been increased materially by the introduction of steamers, and 42c. is a low price for nice Eastern oil."

JULY 22.

Boston reports, July 20th: Menhaden oil—There are orders to buy at prices which the fishermen will not accept. The catch has not been very large during the past week, and the fishermen hold their oil firm at 40c. At the close I understand several lots are being exported, and should a large quantity be exported it would make prices firm here."

JULY 29.

Menhaden oil has been quiet with but little coming forward; the price is steady with 35c. for brown, which is the only kind we are now receiving. The feeling among all parties is that the present is as low as prices will go, and we hear that some of the manufacturers have closed their works on account of the small yield of oil from the fish; as little as one gallon to the thousand is reported in some localities. The sales are 300 barrels at 35c., and 50 barrels at 35½c. Boston reports July 27th, "Menhaden quiet; there are some 700 bbls. being exported, and price remains nominal. Fishermen do not care to sell at anything less than 40c., and buyers will not pay it; all wanting."

AUGUST 5.

Menhaden oil comes forward very slowly, this being what might be termed "between runs," the fish being scarce about the Long Island and Connecticut coasts. Since our last report there have been sales of 150 bbls. at 36c. f. o. b.; 140 bbls. on dock at 35½c., and 75 bbls. pressed at 40c.

Boston reports, Aug. 3d: "Menhaden Oil—The manufacturers are holding nice oil at 40c., but no sales are made; some 500 bbls. have been sold at 38c. and some reported at 36 @ 37c.; the oil being made now is much better in quality than last year at this time."

AUGUST 12.

Menhaden oil is not coming to hand very freely and rules firm in price; a choice light oil is particularly wanted and commands readily 36c., while an oil of dark color will hardly bring 35c. Exporters are in the market. Sales are 70 bbls. choice at 37c. free on board; 400 bbls. to at arrive 35½ @ 36c.; 45 bbls. at 35c. and 20 bbls. at 36c.

Boston reports, August 10th: "Menhaden oil—A sale of 1,000 bbls. has been made at about 35c. The catch has been fair the last week. Dealers stand back and will not buy at 35c."

AUGUST 19.

Menhaden oil is firm in price, as not much is coming forward. There have been sales of 300 bbls. at 35c. for brown, and 36c. for light; in shipping order, free on board, 37c. would probably have to be paid. Boston reports, August 17th: "Menhaden oil—Sale of 500 bbls. for home use at 40c., and for export a sale of 500 bbls. at about 36c. There has been a large quantity exported, taking all the oil as fast as it is made, and it looks as though a better price would be obtained later in the season."

AUGUST 26.

Menhaden oil has come forward rather more freely, but has been taken at about steady prices for home use and export; at the close some lots are offering, and $35\frac{1}{2}$ c. will buy nice oil. The sales have been about 800 bbls. at 35c. for brown, up to 37c. for light, free on board. Boston reports, August 26, "Menhaden oil is being shipped freely, and sales have been made at $35 @ 36$ c. for export. There does not seem to be much activity for home consumption as yet. The price agreed upon by the oil association at its last meeting was 40c."

SEPTEMBER 2.

Menhaden has been quiet, with only one lot of fair brown oil sold for shipment, 83 bbls., at $35\frac{1}{2}$ c. The other lots which have arrived have been delivered former contracts. Boston reports, Aug. 31, "Menhaden oil is firmly held by manufacturers at 40c., but for export a concession of a few cents would be made. There has been 3,000 bbls. exported this season from here, which has taken all the surplus oil."

SEPTEMBER 9.

Menhaden oil has come in rather more freely the past week, and our advices are that the catch is better of late, and the season's production promises to be fully up to last. Prices remain without change, as the consumptive demand is rather moderate and the demand for export, of late, has fallen off somewhat. The sales since our last are 600 bbls. brown and light brown for home use at $35 @ 35\frac{1}{2}$ c.; 200 bbls., as it runs, for home use, at 35c.

SEPTEMBER 16.

Menhaden oil has not come forward very freely of late; the catch is said to be small at the present time, on account of the fish being wild. The demand has not been large, and sales have been made of about 250 bbls. brown, at 35c. or 36c. for light; also some lots sold at $35\frac{1}{2}$ c. for light and brown mixed. Some parties think that this oil is a good purchase at the present price, and we hear of reports of some large transactions, footing up several thousand bbls. direct with the fishermen.

Boston reports, Sep. 14th: "Menhaden oil.—The large sale of several thousand barrels which took place some ten days since has had a tendency to make the market firm, manufacturers holding at $42\frac{1}{2}$ c., but dealers are not disposed to pay it, so no sales."

SEPTEMBER 23.

Menhaden oil has not arrived during the past week, owing to the storm, and we hear of no sales; the price remains firm, but dealers and exporters are not anxious for present wants.

Boston reports, Sept. 21: "There is a disposition among the manufacturers to hold oil at $40 @ 42$ c., but buyers cannot be found at those figures. Carriers are doing but a little, and do not talk as though they would want much oil. Unless there should be a start in trade, prices must rule low."

SEPTEMBER 30.

Menhaden oil has not come forward at all freely, and holders ask an advance on lots on the way. We hear of 300 bbls. offering to arrive. Buyers report a quiet market and show no willingness to meet sellers. We hear that fish are abundant but the yield of oil small.

Boston reports, Sep. 28th : "Menhaden oil remains without activity. The views of buyers and sellers do not harmonize. Manufacturers are holding at 40c. and dealers will not pay over 36 @ 38c."

OCTOBER 7.

Menhaden oil closes firmer, with dealers rather inclined to stock up. We have conflicting reports from the Boston market with reference to Maine oil. Our correspondent does not give us any sales at the asking price of holders, but trustworthy parties here say that 900 bbls. "Gallup" make were sold there to go to Gloucester at 40c. The sales here are 150 bbls., at 35½c.; 100 bbls., at 35¾c.; 370 bbls., on spot, at 36c.; 12,000 gallons, to arrive, at 36c., and a report of 70 bbls. very choice, at 37c.

Boston reports, Oct. 5th : "Menhaden.—There is a stand-still, owing to the difference between the views of buyers and sellers, one side holding at 40c. and the other only offering 35 @ 36c. The fishing season is nearly over, and it is about time to get results of the season's work."

OCTOBER 14.

Menhaden is very firm and the tendency is upward, with a demand both for export and home use. The business the past week has footed up 650 bbls. at 37c. for brown and 38c. for light, including 250 bbls. for export. At the close 40c. is asked and 38c. would be paid.

Boston reports, Oct. 12th : "Menhaden oil.—More demand from dealers, and prices are 38 @ 40c. Manufacturers are thinking of advancing the price to 45c.; if they should it would be holding it out of the market. There have been sales of several hundred barrels at 40c.

OCTOBER 21.

Menhaden oil is higher; the news of the very light catch of Arctic whale oil was the immediate cause of an advance of about 2c. There are now many buyers and few sellers. There were sales following our last of 100 bbls. brown at 37½c.; 350 bbls., for export, at 39½c.; and 300 bbls. Maine oil, at 42c. At the close the market is very much unsettled, but the tendency is upward. Boston reports, Oct. 19th, "Menhaden oil is firmer and is selling at 38 @ 40c., although manufacturers are holding at 40c."

OCTOBER 28.

Menhaden oil is again firmer, and toward the close there was considerable excitement, owing to dealers stocking up. The market closes strong, with many buyers and few sellers. Sales are 78 bbls. ordinary, at 42½c.; 100 bbls., at 43c.; 150 bbls., at 43c.; 90 bbls., at 43½c.; 400 bbls. Maine oil, at New Bedford, at 42c. cash; 600 bbls. do., light colored, to come

here, at 42½c. cash; and later we hear that a further sale has been made in New Bedford, to come here, of about 1,000 bbls. more.

Boston reports, Oct. 26th: "Menhaden oil is decidedly firmer, and held at 42½ @ 45c.; sales of 1,000 bbls., at 40c. and 42½c., and holders are certain that it will bring 45c. within a short time. The season has closed, and the oil has been placed with the exception of about 2,000 bbls."

NOVEMBER 4.

Menhaden oil is rather more quiet, and we think the upward tendency checked for the present. The recent large sales supplied those who were short. For the last few days the fish have been very fat and much handsome oil has been made from them, and while we believe the stock to be undoubtedly small, we think that it is generally underestimated.

Boston reports, Nov. 2d: "Menhaden oil firm and scarce. Sales have been made at 42c., and at close 45c. is asked, and very little oil in the market. Should a brisk demand spring up this market would soon be cleared out."

NOVEMBER 11.

Menhaden oil is easier than at the date of our last. The unusually fine weather during the week has been favorable for taking fish, which have been very abundant, but we learn are becoming less plenty toward the close, and that some of the boats' crews have stopped for the season. Buyers have for the present a full supply, and sellers have been obliged to accept as low as 40c. for brown and 41c. for light oil to-day, though this would seem to be bottom, as this price is bid by others, and most holders ask from 43 to 45c. When fishing ceases entirely there may be an improvement in prices again. There was a rumor in the market about two weeks ago that most of the menhaden in the English markets had been bought for American account. This proves to be a fact, as we now learn.

NOVEMBER 18.

Menhaden oil has again become easier, and at the close nice light oil cannot be quoted at better than 40c. One party claims to have been bid this price for shipment, while from an equally reliable source we are informed that a cargo of 400 bbls. was offered at this price, and the best bid being 38c., it was returned to the manufacturers' factory. Some parties who have oil stored in this city are holding at 45 @ 50c. The close is quiet. The sales during the week have been 500 bbls. Maine oil, in New Bedford, at 42½c.; 60 bbls. choice Long Island sold here at 41c., and 150 bbls. at 40 @ 40½c.

Boston reports, Nov. 16th: "Menhaden oil is selling at 42c.; stocks light, and should business spring up oil will advance."

NOVEMBER 25.

Menhaden has not been pressed for sale the past week, which would, however, have had a bad effect on the market. Receivers are looking about for export orders to relieve our market. Exporters claim that they

cannot pay 40c., which is the price asked. There have been sales of 400 bbls. very choice Barren Island, at 40c., for home use, and 175 bbls. on private terms.

Boston reports, Nov. 23d : "Menhaden oil is quiet, with a light demand, but prices are firm ; sales have been made of 1,000 bbls., at 42½c., in New Bedford, to go to Gloucester and New York. Stock of oil in Boston very light."

DECEMBER 20.

Menhaden oil is very quiet and the price remains nominally unchanged, sellers not pressing goods for sale, and buyers not anxious to take hold, having sufficient to supply their wants for the present. Sales 2,000 gallons, at 40c.

Boston reports, Nov. 30th : "Menhaden oil is firm, and the price remains at 42 @ 45c., with light stock, and should business start up oil must advance to 45 @ 50c."

DECEMBER 9.

Menhaden has been quiet, with not so much offering. There is no particular change to report in prices ; 47 bbls. sold on private terms.

Boston reports, Dec. 7th : "Menhaden remains as last reported, with a small supply and a smaller demand ; oil held at 42 @ 45c. without any sales."

DECEMBER 16.

Menhaden oil has been very quiet for the past two weeks, and the tone is barely steady. A lot of 300 bbls. sold at a private price ; 40c. is probably the full value of nice light oil. We hear that a cargo is on the way to this market.

Boston reports, Dec. 14th : "Menhaden oil.—A sale has been made at about 42c. for 200 bbls. made at Narragansett Bay. Maine oil is held firmly at 42 @ 45c., and it looks as though oil would soon be worth more than these prices, as the carriers are more active."

DECEMBER 23.

Menhaden oil has been quiet all week, and we only hear of 70 bbls., at 38½c., cash ; 80 bbls. were shipped on order.

Boston reports, Dec. 21st : "Menhaden oil.—No sales to note during the week, but holders are firm at 42 @ 45c."

DECEMBER 30.

Menhaden oil is quiet and easy in price ; one lot of 200 bbls. and one of 25 bbls. have sold since our last at a private price. We quote the market about 38c. for good, sound oil.

Boston reports, Dec. 28th : "Menhaden oil is quiet, and will be so until after the commencement of a new year. No sales ; asking 42 @ 45c."

1875.

JANUARY 6.

Menhaden oil is dull, and sales are very few ; prices nominal.

Boston reports, Jan. 5th : "Menhaden oil dull, and not much demand, although oil is held firmly by the few manufacturers that have not sold their product, at 42 @ 45c."

JANUARY 13.

Menhaden oil is in a position rather difficult to report. There are no lots on spot offering, and to arrive 40c. is asked, which buyers as yet are not willing to pay, but 38c. has been bid. There will probably be something done after the manufacturers' meeting to-morrow. We have not heard of a single sale for a week. The last lot was reported at 39c. by seller and 38c. by buyer. We hear that 130 bbls. of light, pressed, have been sold for shipment at 44c.

Boston reports, Jan. 11th : "Menhaden oil remains quiet, without any demand, and the price is nominal."

JANUARY 20.

Menhaden oil is firm, but quiet, at 40c., at which price there are sellers. Buyers have not as yet made up their minds to pay this yet, but there seems to be every prospect that a higher price will be reached before long. The sales are 100 bbls. prime Western at 40c., and we hear of a lot of inferior having sold in New Bedford to go to Boston, 200 bbls., at about 38c. We also hear that a fisherman has bought 500 bbls. on speculation at 40c., but we were unable to learn when it was to be delivered.

JANUARY 27.

Menhaden oil is very quiet ; neither buyers nor sellers being inclined to make any concessions at the present time. The market, however, may be quoted very strong at 40c., and most holders ask more. Since our last there has been but one sale, from a dealer to a dealer, of about 7,000 gallons in casks, at 42c. from store. Boston reports, Jan. 25th : "Menhaden oil is held more firmly at 45c. since the meeting of the oil manufacturers held in New York ; some sales have been made at 40 @ 41c. by parties that wanted to realize."

FEBRUARY 3.

Menhaden oil is dull and very slow of sale ; in fact, there have been no sales, and prices are hardly more than nominal.

FEBRUARY 10.

Menhaden oil has been in more demand, and we look for an active business within the next week or two. There have been sales reported since our last of 500 bbls. of Western oil, at 40c., for March delivery, and this afternoon we hear that 511 bbls. sold at 41c., and about 1,000 bbls. more on private terms ; the advance in gold caused a firmer feeling.

Boston reports, Feby. 8th : "Menhaden oil.—There seems to be more demand, and we note a sale of 2,000 bbls. Maine, at 45c., in New Bedford, and a sale here of 50 bbls. at 45c. Should an active demand arise from consumers it is thought that oil would go to 50c., as all the oil is in the hands of a few manufacturers, and their views are that prices will be higher."

FEBRUARY 17.

Menhaden oil can hardly be quoted higher, though one dealer has re-

cently taken about 2,300 bbls., part reported in our last. The price ranged from 35c. for inferior oil up to 40½c., and not 41c. as reported in our last. The close is firm, and all the lots at 40c. have, we think, been taken.

FEBRUARY 24.

Menhaden has been quiet since our last, the buyers of last week having taken all lots offered at about 40c., and holders now ask 43c. for nice light oil.

Boston reports, Feby. 22d: "Menhaden oil.—A sale has been made, to go to Gloucester from New Bedford, of 200 bbls., which will cost 46½c. delivered. No stock here in first hands."

MARCH 3.

Menhaden has been quiet the past week so far as sales go; there has been some inquiry, however, but buyers have not got their ideas up to sellers. Holders ask from 42 to 43c. for ordinary western oil.

MARCH 10.

Menhaden oil is not offering on spot, but is not wanted; 42c. is asked, to arrive, for a lot of 500 bbls. No sales.

Boston reports, March 8th: "Menhaden oil held at 45c., and some sales reported in New Bedford at that price. If a demand should spring up from consumers, oil must advance to 50c."

MARCH 17.

Menhaden is as dull as any article on our list. A cargo came to hand from Barren Island, but had been sold a long time ago. We expect a cargo of 5,000 bbls. from that place in about two weeks, which will be sold on this market. The price here is nominal at 40 @ 41c.; the lower price would probably be paid for good oil; the higher price might possibly be paid for very choice.

MARCH 24.

Menhaden oil has been dull, and up to to-day there has been but one sale of 60 bbls., choice, from second hands, at 42c. To-day a lot of 200 bbls. sold, to arrive, at 40c. for prime, subject to approval. This is about the price lots will bring on this market, and we do not look for any important advance on this price.

MARCH 31.

Menhaden oil has been more active the past week, and all good lots offering at 40c. or thereabouts have been taken. Sales reported are 500 bbls., choice, to arrive, at 40½c.; 250 do., at 40c.; 115 do., at 40c., and 150 do., part inferior, at 35c., and prime, at 40c.

APRIL 7.

Menhaden oil has ruled quiet, and we have no sales to report since our last; buyers will pay 40 @ 40½c. for nice light-colored oil, while holders would ask 41c.

APRIL 14.

Menhaden oil has ruled quiet since our last, without any particular change, and but few sales are making. There have been several arrivals

of cod oil recently, which meets with a steady sale. Boston reports, April 12th: "Menhaden oil is very quiet; curriers are doing little; hence the demand is light. The manufacturers ask 43 @ 45c., and dealers offer 40c."

APRIL 21.

Menhaden is strong, and in rather more demand, with a sale of 130 bbls. brown oil at 40c., while light would probably bring 41c. Boston reports, April 19th: "Menhaden oil is held firmly by manufacturers at 43 @ 45c., but sales are light. Dealers are willing to pay 40c. Some sales have been made on private terms, probably at about this price."

APRIL 28.

Menhaden oil has taken quite another turn, considerable lots having been sold for shipment; and now that most other oils have advanced, the prospects are that the advance in menhaden will be maintained, even though the early fishing should be very good. The sales since our last have been as large as at any previous time, and create considerable excitement. The particulars of the transactions have been 1,600 bbls. Maine oil, in New Bedford, for export, on private terms, and 3,300 bbls. do., for home use, at 42½c. In this market the sales have been 150 bbls. ordinary, at 40c.; 600 bbls. do., at 41c.; 100 bbls. inferior, on private terms, and 50 bbls. Maine, at 44c., with 45c. asked for the same at the close.

MAY 5.

Menhaden oil has ruled firm in price, and some of our dealers have been buying quite freely and paying the advance asked by holders. The stock is now reduced to a small amount in first hands. The fishermen of Long Island, Connecticut, &c., will "try their luck" on the 15th of this month, and the immediate future of prices depends somewhat on the first catch. Sales here of 150 bbls. Maine oil, at 45c.

MAY 12.

Menhaden oil is just between seasons and hard to report. Some of our dealers have good stocks and some very little. The recent large sale in New Bedford, at high prices, it was thought would have advanced prices here, but we do not notice much improvement. The fishermen, generally, put out their nets yesterday, and expected large hauls if the weather would prove favorable, and the present indications are that there will be a season of warm, bright weather. We hear that some fish have been taken at Greenport, and oil in small quantities is expected here in ten days or two weeks. The success of the early catch will, without doubt, have a great influence on prices. Of course all the first oil is brown and light colored; Maine will not be affected by it, but of this kind there seems to be a good supply in the hands of dealers. Since our last two lots were offered, to arrive, both near at hand, and one of 300 bbls. sold at 41 per cent., and 140 bbls., now in, at 42 per cent. A nice sweet lot of brown was offering at 43c., but could not be obtained.

MAY 19.

Menhaden has been a little unsettled. Holders have been anxious to get rid of stocks before the new catch came to hand, and yet were unwilling to make any important concession. The first new oil of the season came in to-day, two lots, one of 37 bbls. and the other of 14 bbls.; the last lot was of very inferior quality, and brought 39c.; the other lot has not been sold as yet. The news from the fishermen is not favorable, no fish being caught on several days last week, and the yield small. This may be looked on, however, as interested information, with the worst side shown. The fact of 51 bbls. coming in to day shows that some fish must have been caught. The sales of old oil are 1,000 bbls. Maine oil, in New Bedford, at 42½c.; 150 bbls. dark and brown, here, at 41c.; 105 bbls. dark pressed, at 42½c.; 50 bbls. very dark gurry, at 20c.; 40 bbls. shore oil, at 50c. Boston reports, May 15th: "Menhaden.—As the season is approaching when new oil will be coming in, the market is just now a little easier. A few porgy have already been caught in Long Island Sound. We note a sale at New Bedford of 1,000 barrels, comprising about all the stock of Maine oil in first hands. The quotations to day are 40 @ 43c."

MAY 26.

In all, the arrivals this season have been about 230 barrels of new Menhaden oil, most of which is now on dock unsold. After our last, two lots, of about 35 bbls. each, brought 40c.; one was unusually hand some for oil caught at this season. Holders ask this price at the close and future prices depend upon the catch for the next few weeks. We hear from a reliable and thoroughly-posted fisherman that since last Tuesday there have been hardly any fish taken; previous to that good hauls had been made, but the fish yielded only about two gallons. We hear that exporters can pay about 36c., and some buyers intimate that they will hold off till the export price is reached.

JUNE 2.

Menhaden has come to hand to the extent of about 150 barrels since our last. Holders ask 40c. for good new; buyers' ideas are not more than 38c., and 30 bbls. were reported at about this price. The other lots have not been reported as sold.

JUNE 9.

Menhaden oil is quiet, with new oil worth about 37c. for prime quality. The catch of fish is small and the yield light. The arrival of oils has been limited, but trade with the dealers has been dull and their wants small. During the week we hear of the following sales: 125 bbls., 50 bbls., 70 bbls., and 52 bbls., all at 37c.; 100 bbls. on private terms; and 75 bbls., not sweet, at 36c. We also note a sale of 50 bbls. domestic cod, at 58c., and 13 bbls. strictly pure do., at 65c.

JUNE 16.

Menhaden oil has not been plenty the past week, the cool weather not being favorable for catching. The fish are reported as yielding very

little oil, which is of only fair quality. The tanners are very dull, and consequently the consumption of such oils is very light; and dealers report a very dull trade in tanners' oils. Owing to this fact, unless we have an export demand, prices will have to rule very low. Most of the dealers carry a good stock. Sales during the past week that we have reported to us are 46 bbls., at 36c.; 24 bbls., at 36c.; 28 bbls., at 37c.; and 60 bbls., at 37½c. No sales of cod to report.

JUNE 23.

Menhaden is quiet; the demand is light, but there is not much coming forward. The fish are uncertain and the yield small. We hear of a sale for export of 125 bbls., at 36c.; 200 bbls. for home use, at 37c.; 29 bbls., at 37c.; 67 bbls., at 38c.; and 50 bbls., at 36c.

JUNE 30.

Menhaden is dull here, as the demand for tanners' oils is very light. Prices have declined; and sales have been made of 160 bbls., at 35c. and 100 bbls., at 35½c., both cash. The fishermen are doing fairly, and unless we have more home trade, we will have to look to foreign markets for an outlet. We hear that some orders are in the market now, and that one party is busy filling quite a large one which has not been reported.

JULY 7.

Menhaden rules quiet and steady at 35c., with some export demand at this price. The lots which come to hand and sold are 90 bbls., 30 bbls., 25 bbls., 50 bbls., 100 bbls.; part of the last two brought 36 @ 37c. from a consumer and part for export.

JULY 14.

Menhaden has come to hand in fair quantities, and is taken by home and export buyers at 35c. for good oil, which seems to be the market price, buyers being unwilling to pay more and sellers refusing to take less. The shipments of over 1,000 bbls. to Glasgow last week are said to have been pressed Maine oil, and sent on owners' account. The sales here have been 350 bbls., in lots, for export, and 490 bbls. for home use, all at or on a basis of 35c.

JULY 21.

Menhaden is quiet at 34@35c. Following our last, there were two lots of oil offering to arrive—one from Maine, of about 500 bbls., and one of about 150 bbls., Western. A bid of 35c. was asked for these and could not be had in this market, and then 34½c., cash, would have bought. Indeed, the market was weak, owing to a decline of £2 per ton—the market being now £33—in London, and a falling off in the price of gold here, which caused shipping limits to be reduced to about 34c. At the same time there were two home buyers ready to take small lots of nice oil at 35c. on the spot, but their requirements would be supplied with a very small quantity. On Thursday the Maine oil on the way to this market was disposed of to a New Bedford refiner at 35c., and since there have been the following sales: 200 bbls., on spot, at 34½c.; 500 bbls., to arrive, at 34½c.; 50 bbls., on spot, at 35c.; 50 bbls.,

on spot, for export, to complete an order, at 35c.; and a parcel of about 50 bbls., select, on private terms, probably at about 36c.

Our reports from the Western fishermen are that the fishing is poor, and the yield only about $2 @ 2\frac{1}{4}$ gallons per thousand. From Maine we hear that the fish are rather scarce, and the yield about 4 gallons per thousand. The Maine fishermen seem to be adopting a different course this season from last. Last year they carried their stock over into the present catch, but they are sending forward their new oil as early as possible now.

JULY 28.

Menhaden oil has not arrived so freely, but one lot that we heard of last week coming on the market. The demand has been entirely for home buyers, and they have not wanted very large parcels. The decline in gold caused shippers to reduce their limits to 33c., but the advance to-day may help matters, though no effect is yet noticed. To-day three lots came to hand; in all, a little more than 200 bbls. 130 bbls. of this sold at $34\frac{1}{2}$ c.; and 100 bbls., hardly prime, sold at 34c. The other lot is still unsold. Being mostly light-colored, it is held at a higher price. The lot mentioned as having come to hand last week was 135 bbls., and brought $34\frac{1}{2}$ c.

AUGUST 4.

Menhaden has not come to hand very freely, as the catch of fish is small and yield of oil light. In consequence, we are informed that some of the fishermen have closed their works till fall, or such time as the fish yield enough oil to make it pay. While the arrivals have been small, they have been all that the market could bear, and in some instances prices have been shaded a little. There is little or no demand for export, except at 33 c. for light oil. The sales are: 100 bbls. prime light, at 34c.; 66 bbls. do., at $34\frac{1}{2}$ c.; 70 bbls., at $33\frac{1}{2}$ c.; 62 bbls., at $33\frac{1}{2}$ c.; 37 bbls., at 33c.; and 1,600 bbls. Maine oil in New Bedford, at 35c. The Maine make this season, thus far, has been about 5,000 bbls. The yield of oil per thousand fish on Long Island is an average of $1\frac{1}{2}$ gallons.

AUGUST 11.

Menhaden oil has come to hand fairly, and several lots of Maine oil have been offered for shipment. There is no difference in price between Maine and Western oil, the former being in comparatively larger supply. Dealers are buying sparingly, as their trade is dull, and the tendency of prices is downward, toward the price shippers can afford to pay, which, at the present, is said not to be more than 32c. for the choicest lots. This is very low; but the fishermen, said to be making less than former seasons, seem to be forwarding their oil pretty rapidly. On Wednesday, 500 bbls. of Maine oil sold at 33c., and 100 bbls. Western at same price. Thursday a straight lot of 1,000 bbls. Maine was offered at 33c. without finding a buyer. Since then there have been sales of 500 bbls. on private terms. At the close the market looks as though 30c. would be a near-future price.

AUGUST 18.

Menhaden is steadier, but we hear that fish are more abundant and fatter. Tanners are buying more oils. Exporters cannot pay more than 32c.; some lots could probably be sold at this price. The transactions since our last are 2,900 bbls. Maine oil, 900 to arrive in New Bedford and 2,000 bbls. here, at 33c.; 58 bbls. western oil to an out-of-town consumer, at 34c.; 80 bbls. do., at 32c., and 91 bbls. inferior, at 31c.

AUGUST 25.

Menhaden has not changed much in value since our last report. It seems to be about as low as it ought to go, and yet if the catch is large and is forced on the market it may go lower, particularly as there is no export demand of importance, and foreign orders are at very low prices. This is now relatively the cheapest oil in the market. The sales during the week have been as follows: 800 bbls. of Maine, to arrive, at 32½c.; 152 bbls. Sound oil for export, at 32c.; 180 bbls. for export, at 31½c.; 30 bbls. do., at 32c.; 20 bbls. dark brown, at 31c.; 30 bbls. do., at 30c., and 25 bbls. poor, at 29c. A lot of 300 bbls. Maine oil came to a dealer direct.

SEPTEMBER 1.

Menhaden has not arrived in this market very freely the past week. All lots coming to hand have been taken without much urging, mostly for home use. The sales are 70 bbls. Sound oil, at 30c.; 100 bbls. do., at 30½c., both lots a little off from prime; 50 bbls. do. prime, at 31c.; 143 bbls., at 31c.; 150 bbls. for export, at 31½c., and 100 bbls. Maine, to arrive, at 32c. We hear that there are orders in this market for several thousand bbls. for export at 31c. It would relieve our market very much to place some full parcels in European markets. The oil is the cheapest grease in the market. We have just received a letter from a correspondent in the East, the pith of which we give, as follows: The fish are becoming plenty and yielding well. The stock at Booth Bay is 4,600 bbls.; at Round Pond, 3,400 bbls., and at other points in Maine, 8,000 bbls. The hauls of fish on the 28th inst. in Maine were said to have been sufficient to make a thousand bbls. of oil. Another correspondent writes that the fish are yielding 6 @ 8 gallons to the thousand, which is large.

SEPTEMBER 8.

Menhaden oil.—We have a report from Maine dated August 3d which says that the large hauls did not continue beyond the day mentioned in our last and part of another, when the fish fell off, and have since been quite scarce. There have been several shipments, in all amounting to between 2,000 and 3,000 bbls., to New York, Boston, and New Bedford to fill old contracts at 33c.; but now the larger holders have put up their price to 35c. Our market has been quiet, dealers having a fair supply, and, though arrivals have been moderate, no advance has been obtained till towards the close, when shippers have, we think, advanced

their limits somewhat. Sales have been made here of 170 bbls. Sound, 30½c.; 30 bbls., at 31c.; 50 bbls. brown, at 31½c.; 50 bbls. gurry and dark, at 20@28c., all for home use; 90 bbls., at 32½c.; 62 bbls. brown, at 31½c.; 300 bbls. on private terms, and 300 bbls. Connecticut, in Boston, at 33½c., all for export.

SEPTEMBER 15.

Menhaden has been taken more freely for export by parties in this market, who have slightly increased their limits. This does not seem to have any perceptible effect on prices, and dealers who generally have a supply will not pay any advance. The sales reported us are 156 bbls. Sound, at 32c.; 40 bbls. dark, at 31c.; 700 bbls. do., at 32c.; 175 do., at 33c. f. o. b.; 1,000 bbls. Maine, at 33c., and a cargo of about 3,000 bbls. f. o. b., at Round Pond, Me., at 32c., all, or nearly all, for export; also 260 bbls. Maine, in Boston, at 32½c., for export.

Our correspondent, under date of Sept. 10th, at Round Pond, Me., says: Very few fish have been caught, and the fishermen are much discouraged. A good deal of oil has been shipped from here to fill old contracts, and higher prices are asked.

New London, Conn., September 11.

Fish on the Connecticut shore have been quite plenty during the past ten days, and at Lyme and Mystic, where most of the fish-oil works are, the manufacturers have done well.

From Tiverton and Portsmouth, R. I., we hear that the fishermen have done very poorly for the past three weeks, and one of the largest manufacturers that he has made but little more than 300 bbls. this season.

Our advices are that most of the Long Island fishermen are doing well.

SEPTEMBER 22.

Menhaden oil has not changed in position much since our last. There have been very few arrivals, and none of these came on the market, having been sold previously. Dealers are not anxious buyers, and will pay no advance, as they have sufficient stock to meet all wants for some time to come, yet they would probably take any good lots that were offered at present rates, the season being so far advanced that the catch cannot be of much account on the western fishing coast, where it has been pretty poor all season. The Maine catch has no doubt been a good one. Exporters have taken some lots, but there are not many orders now in market. The sales since our last are 200 bbls. Sound, at 32c.; 53 bbls. do., fair quality, in two lots, for home use, at 31c.; and 50 bbls. prime, at 35c. Two lots, one of 200 bbls., at 32c., and one of 140 bbls., at 33c. f. o. b., were delivered to shippers this week. The sales were made some time ago. A vessel is daily expected with a cargo, which will come on the market.

SEPTEMBER 29.

Menhaden oil has come to hand very sparingly the past week, and our reports from the fishermen continue so unfavorable that the indications

are that higher prices will rule in the near future. A letter of recent date says that there are probably not over 1,000 bbls. on the Connecticut shore. This may be an underestimate, but all of our advices are that the amount is very small. The arrivals and sales here have been 100 bbls., at 33c.; 150 bbls., at 33c.; both for export; 146 bbls., at 32½c., and 100 bbls., at 33c., for home use. The lot reported in our last should have been 250 bbls. instead of 200.

OCTOBER 6.

Menhaden oil has been scarce the past week, the only arrivals going on former contracts, one for 180 bbls., for export, at 33½c., and one of 150 bbls., for home use, at 33c.; also a sale of 17 bbls., brown, at 32c. Reports from the fishermen are that there is very little doing, and the prospects are unfavorable. Some of the Maine manufacturers have sent their vessels to the west, but the roughness of the water will not permit them to haul their nets. The tendency of prices would seem upward, particularly for light-colored, and as high as 35c. might be paid for a nice lot. The late fishing may prove good, as it did last year; but at the present time the chances do not seem favorable. Exporters in this market say they can pay no advance, and the only orders we hear of are at 32c.

OCTOBER 13.

Menhaden has been rather scarce of late, and the tendency of the market is upward. A week will decide whether the fall catch will be good or not. At the present time fishing is very poor, but they expect better fish and more of them next week. The arrivals have been about 425 bbls., and 100 sold at 32c., 76 at 33c., 106 at 32½c., and 150 for export on private terms. Buyers will take all lots offered them at present rates. Bleached oil has been advanced, sales having been made of 50 bbls., at 47c., and held at 48c. now.

OCTOBER 20.

Menhaden oil is higher. The catch has not improved much and can hardly amount to a great deal hereafter. Several of the manufacturers report considerable losses in their business, and hope for a run of good fat fish yet. There have been no arrivals since our last, but a small cargo is expected. We think the next sales of good sound oil will be about 36c. Maine oil is now held at 40c. in New Bedford, there having been a cargo sold to arrive there of about 700 bbls., at 39c. Bleached is higher, and 50 bbls. have sold at 50c., for pressed.

OCTOBER 27.

Menhaden oil has been very excited, a movement having commenced following our last which ran up the price so that holders in the East asked above 40c., and sales were made here up to that price, while prices have shown no weakness, 40c. having been bid and refused here for a lot of Long Island oil on spot. The news of a good catch of whale-oil by the Northern whaling-fleet, and letters received to-day from Fall River, where the Maine fishermen are hauling, and also from Barren.

Island, reporting plenty of fish and a large yield of oil, may cause more to be pressed on the market to obtain present rates, and a reaction may take place. The sales reported are 1,400 bbls. in New Bedford, at 37c.; 900 bbls., at 39c.; 500 bbls. on private terms, and 100 bbls. reported at 40c.; 1,000 bbls. of Maine oil to arrive here, at 40c.; 100 bbls. Sound oil to arrive here, at 34c.; 100 bbls., at 36c.; 150 bbls., at 37½c., and 142 bbls., at 40c. There has been much activity in bleached, and we hear of the following sales: 534 bbls., all at 50c., small lots now being held as high as 55c.

NOVEMBER 3.

Menhaden oil has been quiet the past week, but steady in price, even though the reports are quite favorable from the fishermen, who are said to have had a good run all last week. The season has so far advanced now that the catch from this out cannot be very great, and holders are firm in their ideas asking, and we hear of no lots offering for less than 42c., with sales of 850 bbls., at 40c. Part of last week large hauls of mackerel were made by the menhaden fishermen. We hear of a vessel being chartered last week and a cargo of menhaden sent to the East, the boats which caught them not having time to return with their load.

NOVEMBER 10.

Menhaden oil has come to hand more freely of late, as the catch is reported pretty good, but will shortly end. Dealers here take all that come to hand at 40c., but we do not hear of their being willing to pay any more. Sales are 450 bbls. on spot at 40c.; 300 bbls. for forward delivery, and 70 bbls. on spot on private terms, but no doubt at same price. The oil coming now is very handsome.

NOVEMBER 17.

Menhaden oil is firm, and there are free buyers. Most of the fishermen have stopped work. The stock held back is thought to be small, and prices may advance if trade should improve. We hear that the Maine oil in New Bedford is now held out of market. The sales are reported of 400 bbls., spot, at 40c.; 100 bbls. at 41c.; 220 bbls., to arrive, at 40c.; 31 bbls., dark, on spot, at 40c.; 50 bbls., light, to a consumer, at 43c. and 1,000 bbls. in New Bedford reported at 45c.

NOVEMBER 24.

Menhaden oil is high in New Bedford, and we hear that holders there ask 47½c., but our market has not advanced recently. Trade for tanners' oils is light, and dealers will not pay high prices. In New Bedford the oil is refined. The sales here are 245 bbls., to arrive, at 40c. for dark and 41c. for light; 25 bbls., dark, at 40½c.; 35 bbls., good, at 41c., and 140 bbls., selected, at 42c. In New Bedford a lot of 400 bbls. sold at 46c.

DECEMBER 1.

Menhaden oil has been in a hard position to quote. In the East prices are very high and stock scarce. The few lots coming here have

to be sold at about 42c., at which price dealers stand ready to buy, but as most of them have a good stock they are not willing to pay and advance on this, and 258 bbls. just to hand were sold at this figure, though we hear that there are some outside buyers willing to pay more. The fishing is all over, and one of the Barren Island makers has failed and is reported as making a bad showing. In Boston we hear that 100 bbls. Maine oil sold at 45c., and now none offering at less than 47½c.

DECEMBER 8.

Menhaden has ruled firm in price with a small supply offering, but jobbers carrying full stocks. All the oil in New Bedford, some 2,500 bbls., has been taken at a private price, and in Boston there remain only 100 bbls. unsold in first hands. The arrivals here have been about 750 bbls., part of which brought 41c.; also a resale of 200 bbls. at 45c. There are buyers at from 42 @ 43c. at the close for good oil.

DECEMBER 15.

Menhaden is in small stock in first hands, arrivals being light. The 500 bbls. reported in our last are said to have been bought by a Boston house on speculation at an average of about 42½c. There has since been an arrival of 75 bbls., which sold at 43c. to a dealer. The dealers of this city are all carrying a pretty fair stock and will probably realize a good profit on the oil they hold if the consuming trade at all improves.

DECEMBER 22.

Menhaden oil has not been received that we hear of since our last, most of the oil having been sent forward before. We have heard of but two transactions; a lot of 75 bbls. having sold to come from the factory when wanted, at a price not yet made, and 160 bbls. to arrive at 43c. We hear of a lot of Maine offering in New Bedford at 47½c.

DECEMBER 29.

Menhaden is firm in price, and all other fish-oils are tending upward. We hear that two of the contracts made some time ago for bleached were sold some time this month at a premium of \$1 per bbl.

1876.

JANUARY 5.

Crude menhaden oil is in small stock, probably not over 750 bbls. in the hands of fishermen, 1,000 bbls. in first hands in New Bedford, and 750 bbls. in first hands here. The holders ask 50c., and will probably get it. There have been sales of 83 bbls. from store here at 47½c., and 50 bbls. rather poor at a private price, less than the other. All the products from menhaden are comparatively cheaper than the crude article.

JANUARY 12.

Menhaden oil has been taken fairly this week, and the price seems to tend upward, as the supply remaining in the hands of manufacturers

is very small. One large manufacturer has failed recently. During the week there have been sales of 350 bbls., part rather inferior, at 45c. as it runs; we also hear of a resale of 200 bbls. at a private price. Extra bleached menhaden is held as high as 60c., though ordinary is to be had at 55c.

JANUARY 19.

Menhaden oil rules firm in price, but owing to the small supply business is limited.

JANUARY 26.

Menhaden oil rules very quiet, but the small stock of crude keeps prices firm, and should there be only a fair trade prices would advance materially. There is scarcely any going into consumption. Holders here ask 50c., and we heard of 50 bbls. selected selling at this price, but have also a report of 70 bbls. choice having sold within a few days at 45c., though this is below the market at the present time.

FEBRUARY 2.

Menhaden dull but firm, and the manufactured kinds are generally held for more money.

FEBRUARY 9.

Menhaden is unsettled and nominal. To sell a comparatively low price would have to be taken; but there are no lots to be forced on the market. We hear at the close that one dealer is offering to resell, and that some parties who bought to bleach have stored their stock of crude, and have intimated their intention of selling it rather than manufacture, as the price of bleached is not enough higher to pay for bleaching. We hear of pressed and strained both selling at as low or less than the nominal price of crude.

FEBRUARY 16.

Crude menhaden oil is not moving as yet, but holders are firm while buyers are well stocked up and are indifferent, their trade being very light. There has been more doing in pressed, and we heard of a sale of 70 bbls. on private terms, and 50 bbls. at 50c., with holders asking 52c.

FEBRUARY 23.

Menhaden has been quiet, as a rule. At the date of our last we were informed that negotiations were pending for export, and on Wednesday a lot of 500 barrels—which had been held by a dealer—was sold, to go to Havre, at 48½c. This has the effect of stiffening prices, which before were nominal. The stock in first hands is very small, and if any large orders should come into market they could not be filled, except at a high price; at the same time a lot thrown on the market would have to sell rather low.

MARCH 1.

Menhaden oil is as quiet as can well be, no stock offering, no buyers wanting. Price nominally firm at 50c. Bleached and strained are very slow of sale.

MARCH 8.

Menhaden oil is in the same position it has been for a long time past, not enough doing to make a market. Dealers have a supply for their dull trade, and no further export orders in market. There are a very few parcels held by first hands, and these are not pressing for sale; only one do we hear offering at 48c. Dealers are generally inclined to work off stocks of bank and strails at quoted rates.

MARCH 15.

Menhaden has sold in this market since the lot for shipment at 48c., as follows: 50 bbls. at 48c., and 100 bbls. to arrive at 46c. There has been a sale in New Bedford of 300 bbls. at 46c. there to come here.

MARCH 22.

Menhaden has not sold since our last, notwithstanding some commercial journals reported sales of 2,000 bbls. This lot has *not* been sold, and is now offering. Several weeks ago a bid of 45c. was made on it delivered in New Bedford, but the holder refused to sell. We heard of 50 bbls. dogfish selling here at 47c. Tanners are buying very sparingly.

MARCH 29.

Mehaden is dull, none pressing for sale; no demand except at low prices. Holders ask 50c.; buyers would pay 45c.

APRIL 5.

Menhaden is generally quiet, but there has been a lot of 300 bbls. sold at a private price, reported at about 46c. in store.

APRIL 12.

Menhaden is rather uncertain. Fishing will commence in about a month, if the weather is warm. Trade is dull. The stock is light. Holders do not want to part with their goods unless at full or an advanced price, while buyers are inclined to act with great caution, and not take unless at a concession. Since our last, a lot of 160 bbls., said to be Maine rejections, sold on private terms, and to-day we hear a rumor that 1,000 bbls. of Maine sold in New Bedford to a manufacturer at 46c. or better. If this is so, it will leave only about 1,300 bbls. in first hands, and probably a very moderate stock with dealers. We note sales of 75 bbls. bleached, at 52c.

APRIL 19.

Menhaden has not sold since our last report, but the feeling is easier, and the choicest lots can now be had at 45c. The first fishing steamer will be started out the 27th of this month, by V. Koon & Son. The stock of oil is small, but probably more than can be sold before the new reaches the market. There was a sale of 100 bbls. bleached, at 50c.

APRIL 26.

Crude menhaden is in a peculiar position. If a large lot were forced on the market, a low price would have to be taken, and there are one or two large parcels which could be bought at easier prices, but the holders are not willing to accept any decline for small portions of them.

Buyers will not take more than they want from week to week, and, as a rule, prefer paying a little more money for a small lot than they could buy a large parcel for.

There is a rumor in the street to-day that 500 bbls. have sold at 46c., but one parcel, at least, can be had at 45c.; a sale of 50 bbls. at 46c.

MAY 3.

Menhaden is dull. We hear of no sales from first hands since the 500 bbls. which we reported last week, which was for export to France, and at a private price. A dealer sold 25 bbls. to a consumer at 48c. for choice.

MAY 10.

Menhaden is quiet and easy, prices tending downward. The fishing has not fairly commenced, but we have had two lots of new oil in; the first, 17 bbls., came last week to Cory & Co., and was refined; this week 40 bbls. came to T. G. Hunt, but has not been sold. The quality is good. The only sale we hear of is 150 bbls., good old oil, at 44c.

MAY 17.

Menhaden oil has declined during the past week, and closes at 35c. for prime new oil. The arrivals the past week of new have been about 600 bbls., of quality equal or superior to any ever before made. While our dealers carry but small stocks of old, the loss on this is very large, and they have not been in a position to materially lower prices for the manufactured kinds; but with a pressure to sell, the tendency is downward.

The oil catch promises to be large, the fish being very fat and yielding well. The probabilities are that as low prices will rule as last year, unless we have a good export demand. The sales are 25 bbls. bleached, at 50c.; 100 bbls. do., at 48c., and less would probably now buy; 100 bbls. old crude oil in New Bedford, to go to Boston, at 44c.; 325 bbls. old, here, at 41c.; 150 bbls. do., for export, at 37½c.; 200 bbls. do., at 35 @ 36c., and 17 bbls. at 35c.

MAY 24.

Menhaden oil has come to hand rather sparingly the past week, and the few lots on the way have nearly all been sold. The price is 35c. for good oil, and must be regarded firm under the present circumstances; but should there be any large hauls of fish, or the yield increase, prices must go lower. Our dealers carry a small stock, but are not inclined to buy any quantity at the present time. Should their trade improve, however, and the catch of oil continue light, they would come into market in about two weeks, and probably pay an advance. The latest report from Long Island coast, and the sound, is that the fish are not plenty, small, and yielding two gallons, poor quality. There is considerable speculation as to future prices, and it is generally believed with an average catch, such as last year, prices will range from 30 to 35c.; but should there be a catch equal to year before last, considerably less than 30c. would be reached, or a price low enough to induce exporters to

take large parcels. The sales, since our last issue, have been 260 bbls. to arrive, at 35c., and a resale of 90 bbls., and some selected on private terms. Bleached, pressed, are all easier, and somewhat irregular in prices, tending downward.

MAY 31.

Menhaden oil is firm under light arrivals, only two or three parcels coming in that had not previously been placed and reported. The news from the fishermen is, that at Barren Island the fishing is fair, but the yield only 3 gallons good quality. The east end of Long Island report few fish and little oil of poor quality. An arrival of 80 bbls. was placed, mostly for export, at 35c., and a parcel of 74 bbls., from New Haven, "Q" brand, as it ran, mostly light colored, at 35c. There has been a small sale of herring oil at 30c.

JUNE 7.

Crude menhaden has not arrived very freely, and the fishermen report few fish, but we are inclined to think that more are caught than reported. At the close we also hear of several parcels at the works offering for sale. Last week there were arrivals of 465 bbls. of fair brown oil, most of which sold to dealers; one lot of 150 bbls. was placed for export, all at 35c. In New Bedford, 3,000 gallons choice light sold at 36c.

JUNE 14.

We note a decided improvement in our menhaden oil market. Reports from the fishing grounds state that the fish are very scarce, and unless they become more plentiful most of the gangs will haul up as they are not able to pay their expenses, and are going behind every day. In the absence of positive sales it is a hard matter to give any reliable quotations; a prime lot would no doubt bring 36c. Dealers are on the lookout for small parcels of prime, but do not feel disposed to bid over the above price; a lot was offered at 37c., but was not taken that we hear of.

A letter to hand to-day says: "I give you our report for the past two weeks, which is probably identical with all the sound fishing, viz: The catch has been exceedingly small and the fish very poor, not yielding some of the time but about two quarts to the thousand. They improved slightly the latter part of last week, but are still in small quantity and comparatively poor. The Maine fishermen are just about commencing work, and unless they have better success there will be a scarcity of oil and an advance in prices."

JUNE 21.

Menhaden oil has continued to advance with small arrivals. The demand from dealers is not large, but their stocks became almost entirely exhausted, and were willing to pay higher prices. Until to-day there have been hardly any lots in, and though the steamer to-day brought several large parcels, most of them had been placed before arrival. The sales are 37 bbls. at 35½c., 30 bbls. at 36c., 50 bbls. at 37½c., 200 bbls. at 38c.,

and 64 bbls. at 38½c., all to arrive; on spot to-day 63 bbls. sold at 38c.; most of these last were sold as they run, not selected. Fishing advices are as follows: "Fish are quite plenty and fat, but are very wild and hard to get." Another report to hand to-day, dated June 19, says: "The catch of menhaden last week was the smallest catch of any week thus far this season in Long Island Sound. The few caught were better quality than for the preceding fortnight."

JUNE 28.

Menhaden oil has come to hand more freely, and the fishing has also improved; consequently prices are again lower and tending down. The sales are 42 bbls. at 38c., 27 bbls., the first from Barren Island, at 38c., 98 bbls. at 37c. and 75 bbls. at 35 @ 36c., closing with buyers at these lowest prices.

JULY 5.

Menhaden oil has come to hand more freely, and the fishing has also improved; consequently prices are again lower, and tending down. The sales are 42 bbls. at 38c., 27 bbls., the first from Barren Island, at 38c., 98 bbls. at 37c., and 75 bbls. at 35 @ 36c., closing with buyers at these lowest prices.

JULY 12.

Menhaden oil has not come to hand since our last report, except 93 bbls., which sold at 36c. for light and 35c. for brown, and 50 bbls. yesterday, which sold at 35c. as it run. The market is steady, and there are buyers at 36c. for good oil. We hear that while the fish are quite plenty they are very poor, yielding only one gallon per thousand, and that there is not much oil at the factories. Reports from Maine are that the fishing is not very good, and the stock on hand about 1,000 bbls. They are reported to have made some sales to Boston at 37c., and one parcel of 250 bbls. sold at 38c., delivered in New Bedford.

JULY 19.

Menhaden oil has come to hand pretty freely of late, the Sound fishing having improved very much the past two weeks. The Maine fishing is also reported better, and their prices have been lowered to make sales. During the latter part of last week there were large arrivals from the Sound catch, in all some 1,200 bbls., and been placed, as nearly as we can trace them, as follows: 130 bbls. at 35c., 100 bbls. at 35c., 93 bbls. at 35½c., 60 bbls. at 35½c., 80 bbls. at 35½c., and 100 bbls. on private terms, all on spot; and to arrive here 200 bbls. at 35c., and in New Bedford 600 Maine, delivered there at 35c., the buyer's price and 36c. the seller's price.

JULY 26.

Menhaden oil became weaker following our last, as sellers continued to offer and buyers had a supply, and the market went down to 34c., with a sale at this price; but, though other goods were offered at this, buyers would not take them, and there was a lot placed at 33c., and to-day we hear that 32½c. was accepted for good brown oil. The sales made foot up 600 bbls.

AUGUST 2.

Menhaden oil has not come to hand in any quantity the past week, but, owing to the fact that most of the dealers are well stocked up, they are not anxious buyers, and the price has not improved. The reports from the fishermen is that there have been but few taken, and they yield a very small quantity of oil. There has been one sale of 100 bbls. at 33c., but lots can be had at 32½c., with no buyers at better than 32c. for ordinary quality.

AUGUST 9.

Menhaden oil is dull; dealers, being stocked, are not anxious to buy; and, though the fishing is reported as being very poor, no advance can be obtained. A choice lot of 290 bbls. sold at 33c., but an ordinary parcel could have been bought at 32c., and, not meeting with sale, was put into store.

AUGUST 16.

Menhaden oil has not come to hand very freely, but the supply is equal to the demand, as dealers have a stock and do not care to buy large lots except at a low price. There has been a shipment of 1,000 bbls. Maine, oil sold at 34c., and 400 bbls. Sound oil, part for shipment, at 32 @ 33c.

AUGUST 23.

Menhaden oil has not come to hand to any extent the past week, and the sales are of only two parcels, in all about 400 bbls., for export, at 32c. for Sound make and 33c. for Maine make. The reports from the Long Island coast is that the fish are quite plenty, but the yield of oil is so small, that there is an actual loss in the business. The Maine fishing is very good, the fish being ordinarily fat. There are offers to sell brown oil here at 32 @ 33c., but dealers are not anxious buyers, but want a light-colored oil, for which they are willing to pay the highest figure. There are exporters willing to pay 32c. for Maine oil, but though there may be a disposition on the part of the Eastern makers to accept this price, there is a good deal of difficulty in obtaining a vessel to take freight direct from a Maine port. Unless there can be some sales made for shipment, there will probably be a surplus on our market all year, with no probability of an advance.

AUGUST 30.

Menhaden oil has been quiet, with moderate arrivals. Buyers will pay 33c. @ 34c. for a light-colored lot, but most of them have a supply of dark colored, and are not willing to pay so much. There were sales of 400 bbls. at 33 @ 34c. and 75 bbls. on private terms.

SEPTEMBER 6.

Menhaden oil has not come to hand very freely, and the market is rather stronger for light-colored oil. The trade will pay 34c. for good, light, sweet oil. The sales are, 100 bbls. at 33c., 80 bbls. at 33c., 200 bbls. at 34c., 49 bbls. at 34c., and 60 bbls., irregular quality, at 34c. for prime.

SEPTEMBER 13.

Menhaden oil.—The market continues firm for this article, and holders are asking 34 @ 35c. for a prime article, but we note sales of 400 bbls., at 33 @ 34c. The Sound catch has been light, and the prevailing price for this product has been 32 @ 33c. from brown to light, but holders are asking an advance on Sound makes, 34c. for brown and 34 @ 35c. for light. The Maine catch of fish is mostly over, and the catch has been very fair as to quality and excellent as to quantity, but still not up to former seasons as regards quantity. Dealers and manufacturers, especially in Boston, have bought more freely of Maine oils than other makes. The present price for Boston, New Bedford, and New York delivery is 35c. The stock at New Bedford is reported small, with a small account held back by fishermen for higher prices. The future of this market is, however, uncertain, as there remains yet two months for fishing from Maine to south side of Long Island, and the conclusion is that prices will depend on this future catch, and it is doubted if exporters can take any considerable quantity if prices advance too far.

SEPTEMBER 20.

Menhaden oil.—The market remains steady and without change as regards prices since our last. The eastern catch is now about over, yet the fishermen are still hauling up the fish, and the balance of the catch is very uncertain, depending entirely upon the weather; and 33 @ 35c. is likely to be the ruling prices for at least the balance of September. There is little or no oil in first hands in this market. We note sales of 600 barrels Maine oil at 34c.

SEPTEMBER 27.

Menhaden oil.—The sales for the past week have been only in a jobbing way (if at all), and prices remain about as last reported. The weather for the past week has been unfavorable for the fishermen, and the main gangs have laid up, while the Long Island fishing is poor. Sales of a parcel of rejections have been made at 30c., but holders seem firm in their views at 34 @ 35c. for prime oil. We note sales of 1,690 bbls. bleached at 44½ @ 46½c. cash.

OCTOBER 4.

Menhaden oils have been very quiet here, as there have been no arrivals here of any account, and the market is nominally firm. The only sales are 100 bbls., at 35c. for prime and 30c. for inferior, and 100 bbls. inferior at 30 @ 31c.

Thus far the Sound fishing has been a failure, but they are expecting the fat large fish which have been so plenty in Maine to come to the Sound yet. The fish they are now taking are very small and yield no oil. The Maine fishing has been splendid, and one oil manufacturer is said to have made 10,000 bbls. of oil.

OCTOBER 11.

Menhaden oil is higher, as the fishing in the Sound has not improved.

One fisherman reports having taken only 5 bbls. from 400,000 fish. There are no offerings of any account, and good oil is wanted at 38c., and a choice lot might bring 40c., as the stock in the hands of dealers is small.

There have been no sales here this week that we learn of, but last week 100 bbls. brown sold at 35c., 700 bbls. fair at 35c., and 36 bbls. prime at 37c.

OCTOBER 18.

Menhaden oil is scarce and higher, as there have been no arrivals. The supply here is mostly in a few dealers' hands, and there is said to be very little oil left on Long Island Sound, but we also hear that the catch is better in Narragansett than at any time this year, and one maker took 400 bbls. of oil in the last ten days. The price will probably rule firm, however, as the fishing can hardly last long enough to get more than is actually wanted, and should there not be a continuance of the good fishing there may be an actual scarcity, which would result in very high prices. At the close, spot oil will bring very high prices, and one party holds good crude at 45c., with a sale of 200 bbls at 42c. The large movement in the East will advance prices there also. The past two days have been too windy for taking fish, and several gangs of fishermen have hauled up. The only sales here are 200 bbls. from second hand at 38@40c., the latter price paid at the close. We also heard of 250 bbls. Sound oil to arrive, and the make for the balance of the season of the two largest concerns to a dealer at a private price.

OCTOBER 25.

Menhaden oil is firm and active, and advanced prices are likely to be established unless the present fine weather should continue, which will enable the fishermen to make a month's catch yet, which will likely give a supply sufficient for the wants of the trade, yet the advance in whale-oil may so affect the market as to counteract the coming catch, and thereby cause prices to go still higher. We hear of recent purchases of 300 bbls. of Sound oil which have been put in store at a private price, but probably at 40c.; holders are now asking 45c. here, and we hear of no sales at less than 42c. for a prime article.

NOVEMBER 1.

Menhaden oil is hardly so strong in price as two weeks ago, as the catch in the Sound and Narragansett Bay has improved considerably; at the former place fish are plenty and fat, yielding a choice oil. There will, however, be no material decline in prices, unless the make should be very large, as the supply in the hands of dealers is not sufficient to carry them through the season, and there are said to be export orders at 42½c. The sales since our last are 350 bbls., Barren Island make, to arrive, at or about 42c. There were arrivals of 400 bbls., which had been sold some ten days or more, at 40c. Pressed oil has been sold in 25-bbl. lots at 45c.

NOVEMBER 8.

Menhaden oil is easier and lower since last week, on account of the

larger catch at Barren Island and Narragansett Bay. We hear at the close, however, that the fish are falling off and poorer, yielding only 5 to 6 gallons per thousand. We hear of sales of 650 bbls., ranging from 38 to 42½c., as to quality, with 40c. about the top price that any buyer would pay, and we hear that any bids made for round lots are much below this figure.

NOVEMBER 15.

Menhaden oil is fairly active, with the catch about over. There are only a few fishing gangs and two steamers on the Sound, and the Narragansett fishermen stopped last Saturday. The transactions foot up for the week some 750 bbls. at from 40 to 42c. for prime quality, closing firm, with the large holders asking the higher price. The Maine oil is held out of market.

NOVEMBER 22.

Menhaden oil is steady though not materially changed in price. The fishing season is now about over, and the supply to come forward cannot be great, and many parties look for an advance. The sales are 150 bbls. and 66 bbls., both a little off quality, at 40c.; 170 bbls. good at 41c., and 200 bbls. choice at 42c. The Maine oil in New Bedford is held out of market. Bleached is dull at 50c., light strained at 45@46c., bank at 44c., straits at 46c.

NOVEMBER 29.

Menhaden oil has ruled firm at an advance for very choice lots; other grades are quiet. The sales are 98 bbls. at 40c., 150 bbls. at 40c., 270 bbls. at 40½c., 165 bbls. at 41c., 100 bbls. at 42½c., and 150 bbls., very choice, at 43½c.

DECEMBER 6.

Menhaden oil is steady, but as trade is moderate the few parcels coming to hand will not bring any advance. There are some offerings at the close, but they are not large. The sales reported are 18 bbls. ordinary, at 40c.; 150 bbls., a mixed lot, light and brown, at 40c.; 160 bbls. choice, at 41c.; and 121 do., at 41c.; also, 180 bbls., at 40c. for brown, and 42 for selected.

DECEMBER 13.

Menhaden is quiet, with small sales and few arrivals. The sales reported are 240 bbls. prime Sound make, at 40½c., and 70 bbls. inferior, dark and strong, at 40c. The business done in pressed and bleached is rather light at about former prices.

DECEMBER 20.

Menhaden oil is very quiet, as arrivals are light, but still dealers would not be inclined to buy until after the new year. Holders ask 40@42c., with buyers willing to pay about 40@41c. Sales, 50 bbls. good Sound make, at 41c. There is a report that a sale was made of 400 bbls. Maine oil in New Bedford, at 44c., but we have not the report verified.

DECEMBER 27.

Menhaden oil is very quiet, as arrivals are light, but still dealers would not be inclined to buy until after the new year. Holders ask

41@42c., with buyers willing to pay about 40@41c. Sales of 50 bbls. prime Sound make, at 41c., and 60 bbls. light colored, a little off in quality, at 40½c. We are informed that a bid of 44c. from Boston has been refused for a large line of Maine make.

1877.

JANUARY 3.

Menhaden oil is very quiet, as arrivals are light, but still dealers would not be inclined to buy at any advance. Holders ask 41@43c., with buyers willing to pay about 40@42c. No sales reported. We have noticed that the annual meeting of the Menhaden Association will be held Jan. 10th, at New York.

JANUARY 10.

Menhaden oil has been quiet for some time past, and dealers would not take hold except at some concession in price, but this the holders were not inclined to grant, and there were few sales for several weeks past; but within a few days there were sales of 1,000 bbls. Maine make in New Bedford, to go to Boston, said to be off in quality, and we suppose the price not to be far off from 40c. In addition to this, 468 bbls. sold to come here, and 590 bbls. Sound make sold here; but we are requested to withhold terms. There was a lot of 150 bbls. offering within the past day or two, but was not sold that we hear of. The above transactions would indicate an easier market, but the advance in cotton-seed oils may cause a firmer tone.

JANUARY 17.

Menhaden oil is not changed, but is dull. Holders are, however, generally firm, and look for an improvement in price later on in the season.

JANUARY 24.

Menhaden oil has been very quiet, and there have been but few sales for several weeks past. Prices are maintained, as the stock is light. The only sales we hear of are 50 bbls. prime, at 42c., and 75 bbls. light pressed, at 46c.

JANUARY 31.

Menhaden oil remains nominal, as there are no arrivals, no demand, and no sales. The advance in cotton-seed oil, however, is expected to have an effect on these.

FEBRUARY 7.

Menhaden oil has not moved to any extent since our last, and prices have not improved. The only sale we hear of is a lot of 100 bbls. prime light at 45c. cash.

FEBRUARY 14.

Menhaden oil is dull and the price is quite nominal, as there has been no sales in the regular way for some time past. Buyers' ideas are 40 @ 41c. for good Sound oil, while sellers hold for 2 @ 3c. higher prices. It is reported that a Boston party has bid 45c. for a lot of Maine oil, and this was refused. Pressed and manufactured oils are not changed in price, but a small parcel of the former is said to have been sold low for cash.

FEBRUARY 21.

Menhaden oil still remains quiet, and we do not hear of much offering from first hands. Some of the smaller dealers are in small stock, and we heard that 150 bbls. very handsome late fall catch sold from second hands at 42c., and 78 bbls. do. at 42½c.

FEBRUARY 28.

Menhaden oil is a little more active, as the stock in the hands of some dealers is becoming light. Sales are 150 lbs. crude at 42c. on spot, and 180 bbls. to arrive at 41½ c., both for home use.

MARCH 7.

Menhaden oil has been offering more freely the past week, those having stocks being inclined to market them before the new season begins. Dealers are not willing to buy except at low prices, and we heard of sales of 100 bbls. Maine at 41c., and 159 bbls. Sound at 40c. Pressed and manufactured menhaden is easier, and we heard of 100 bbls. sold for export at 42½c.

MARCH 21.

Menhaden oil is dull and offering more freely, with buyers holding off and bidding 39c. Most sellers are firm, however, and one of the largest holders asks 45c. for Maine catch. The price is unsettled and nominal, and may advance or decline in the near future. The only transaction we hear of is 125 lbs. Maine at 41c. Pressed oil is offering low from Boston, but a special lot which can be had at 41c. laid down here is said to be off quality.

MARCH 21.

Menhaden oil is still quiet, but the stock is becoming reduced and chiefly in the hands of one party. One parcel of Maine has recently been closed out, though mostly reported by us before. There was in all some 850 bbls., and brought from 41 to 42c.

MARCH 28.

Menhaden oil continues quiet, though there is rather more inquiry, some for export, but, as a rule, limits are far below the market price. The only sales we hear of since our last are 70 bbls. for export at 41c., and 50 bbls. for home use at 41c.; both lots were Maine make. We also heard of a sale of 100 bbls. choice pressed at 43½c.

APRIL 4.

Menhaden oil has been very dull for some time past and is lower in price, good quality offering here at 40c. without finding buyers. There have been no sales here, but in New Bedford a sale of 500 bbls. dark-colored is reported sold to go to Boston at a private price. The manufactured fish-oils are in little better demand, but prices are easy.

APRIL 11.

Menhaden oils are easier, as those holding supplies of crude have been anxious to sell, and purchasers could be induced to take stock only by liberal concessions from holders. The trade generally have a suffi-

cient stock to supply their wants till new oil reaches market, but should the catch be later than usual there might be a week or more of scarcity; but dealers are generally willing to take their chances rather than buy at present. The sales reported are 307 bbls. on private terms. There was a lot, a little off quality, sold at 38c.

APRIL 18.

Menhaden oil has been weak and drooping for some time past, and to sell low, prices would have to be accepted. There was an export demand but at a low price which has been accepted for 1,000 bbls. The terms are kept quiet, but a similar lot would probably not bring better than 35 @ 36c. We hear of a small lot of Southern new in market, but no price has yet been named for it.

APRIL 25.

Menhaden oil has been offering freely of late by parties who held stock over from last season in anticipation of higher prices this spring. The consuming trade have taken less than usual and prices were held too high all winter, and until recently, for exporters to make purchases. During the past two weeks, however, holders determined to make sales, and as it would not be taken at home, prices were named that met the views of shippers, and some 3,000 bbls. have been placed for shipment, said to have been at 35 & 38c.; this includes sales reported in last issue, since which we hear of 175 bbls. at 35c., 900 bbls. Maine at 38c., and 500 bbls. on private terms. The first new oil came in last week, a small lot of 11 bbls. Southern, and a little off in flavor; this was sold at 33½c., a full price.

MAY 2.

Manhaden oil was easy just previous to our last report and there were sellers at 35½c., but the following day buyers for export came into market and paid 37½c., delivered, for 500 bbls. A sale was then made for home use of 300 bbls. at 37c. and since 100 bbls. at same price. At the close there are further negotiations for export, but holders have advanced their views. A Long Island newspaper of last week contains the following item, which shows that fishing has commenced:

"Bunkers caught in the pounds, but not many yet. Cassidy Bros. at Asshamomoque took 3,000 one night. The purse-net gangs were out early in the week, but got no fish until Wednesday, when Capt. E. Tallman took 37,000 and Capt. Jas. Downs about 80,000 fish of very good quality, all of them being quite fat for so early in the season. Capt. Mart. Griffing also took 100,000 the same day."

MAY 9.

Menhaden oil has come to hand freely, and that of the new catch is unusually handsome. During the last week one commission merchant sold 1,000 bbls. for export as it arrives at 37 @ 38c. The recent sales reported are 100 bbls. new at 36c.; 25 bbls., 36c.; 250 bbls. old on private terms, said to be 38c. At the close there is not much offering, and the market is steady at 37c. A Greenport, L. I., journal of the 5th says:

"The season has opened this year more successfully than ever before. We gave a few figures last week of the first day's catch by some of the gangs on Gardiner's and Peconic Bays. On Friday and Saturday Capt. J. S. Biggs took 247,500, and on Monday he took 250,000. Capt. Mart. Griffing also made large hauls, but we did not get the precise figures; however, up to May 2d he was 'high hook,' having taken about 670,000, while the next nearest catch was that of Capt. Talman, who had taken 635,000. On the 1st, seven steamers, including two from Connecticut and two from Rhode Island, were fishing in the bays."

MAY 16.

Menhaden oil is steady, as the export sales for the past few weeks have left no surplus on the market, and dealers are not very well supplied. The arrivals for the past week have not been large, and fishing is said to have fallen off a little. The sales reported are 20 bbls. dark at 36c., 200 bbls. prime at 37½c., 60 bbls. at 38c., and a small lot of Southern at 35c. A Greenport journal says:

"The catch of menhaden has been light this week. Unfavorable weather and the departure from the bays of the first 'run' of fish, have prevented most of the gangs from getting many. On Tuesday, Capt. Tallman, of stmr. E. F. Price, took 150,000 in the ocean off East-hampton."

A Sag Harbor journal of the 10th says:

"During the last two weeks the bunker or menhaden fishery has been very brisk, exceeding that of any previous season of late, both as to the fatness of the first run and as to the time of striking on the coast, the fish coming into our waters some two weeks earlier than usual, and making four to five gallons of oil to the thousand. During last week the Sterling Oil-Works at Cedar Point took in 800,000 fish, and in three days of the same week Wells's factory took 1,000,000."

MAY 23.

Menhaden oil is not coming to hand very freely, as the catch of late has not been very good, and most of the new had been sold before for shipment. The old stock is about closed out. The sales reported are 900 bbls. old and 300 bbls. new, for shipment at 37 @ 37½c. 50 bbls. new at 36c., and 75 bbls. at 35 @ 37c.

MAY 30.

Menhaden oil is rather easier at the close. The catch has been fair, but the export orders had been mostly filled, and the lots are now coming on the home markets. The sales reported are 160 bbls. at 37c., 110 bbls. at 36½c., and 70 bbls. at 36c., with sellers at the close at this price.

JUNE 6.

Menhaden oil has been more plenty and prices have declined as home buyers were getting full supplies and exporters not taking. The market closes quiet. The sales since our last are 70 bbls. at 36½c., 90 bbls. at 36c., 80 bbls. at 35c., and 250 bbls. at 34c.

JUNE 13.

Menhaden oil has settled down to 34c., at which price there has been a good trade doing, and the market seems steady with the following parcels placed: 400 bbls. at 35c., 150 bbls. at 34c., 75 bbls. at 34c., 50 bbls. at 34c., 94 bbls. at 34c., 62 bbls. at 34c., and 110 bbls. at 34c.

JUNE 20.

Menhaden oil has come to hand quite freely, but prime quality has ruled steady at 34c., though some off-grade was offered to-day at 33c. The sales reported for the week are 250 bbls. at 34c., 80 bbls. at 34c., 96 bbls. at 34c., and 156 bbls. at 33½c. Light strained oil can be had at 38c., bank at 39c., and straits at 40c.

JUNE 27.

Menhaden oil has come to hand quite freely, but a good deal had been sold before, a small part for export. The market is steady, with buyers at 33c., but it would be difficult to get a much higher price for a round lot. The sales reported are 300 bbls. at 33c., 156 bbls. at 33c., 67 bbls. at 33c., and 50 bbls. at 33½c. We also hear of 200 bbls. in New Bedford on private terms. We print an item below which would show that the catch is large, but we hear since by letter that the fish are running poor, and the oil from them dark.

"For the first time this season some considerable numbers of menhaden were taken in Gardiner's and Peconic Bays last week. On Monday Capt. E. Tallman took 64,000 in the lower bay; and again on Friday, after taking 150,000 at two dips in the ocean to the southward of Amagansett, in coming up to the factory he got 60,000 from them, making his day's catch 210,000. Capt. Israel Warner also made several good hauls of fish in the upper bay, the first we have heard of in that vicinity. While the quantity of fish in the outer ocean has been practically limitless, and every gang who could go outside to get them has been able on every fair day to make good catches, by a remarkable departure from the usual fact heretofore, few or no fish have entered the bays. Indeed, it is asserted that of all those so far rendered into oil and guano at the factories on shore, or in its limits, not one million in all have been caught in the bay. Opinions differ as to the cause or causes of this result, but the general belief is that the presence of food has been the determining element in the question. Food has been and continues abundant in the ocean, hence the fish stay outside. Except for a few days of thick fog the weather has been quite favorable, and many fish continue to be taken.

"Greenport, L. I., June 23."

JULY 4.

Menhaden oil has ruled steady, with no great surplus offering, the arrivals being moderate, and some lots taken for export. The sales reported are 250 bbls. at 32½c., 75 bbls. at 32½c. for home use, and 200 bbls. at 33c., free on board for export.

"Steamer E. S. Newins, Capt. J. W. Hawkins, was in port on Wednes-

day. On Tuesday she took 125,000 menhaden in the ocean off Quogue, and reports immense bodies of the fish at that place. It is also reported that the shore seines along the Hamptons have been taking great quantities of the fish lately. The advantage of employing steamers is shown strongly in the fact that the Newins on her Tuesday trip out and back traveled about 150 miles, a distance quite out of the question for sailing vessels."—Long Island Journal, June 30, 1877.

JULY 11.

Menhaden oil is not coming on the market in large lots, as a good deal of the arrivals are going on shipboard. The different sales for home use that we hear of are 78 bbls. at 32½c., 60 bbls. at 32½c., 80 bbls. at 32½c., 46 bbls. at 32½c., and 71 bbls. at 32½c.

JULY 18, 1877.

Menhaden oil came to hand sparingly last week, the fishing both in the Sound and on the coast of Maine having been poor for some time past. The reports to-day are, however, more favorable. The market has been steady, but not active; no export orders at the moment. The sales reported are 150 bbls. at 32½c., 58 bbls. at 33c.; and a lot of 100 bbls. good, fair quality was offering to-day at the latter price.

The total exports from the United States, from January to June 30th, were 11,010 bbls.

JULY 25.

Menhaden is in small demand for home use. The arrivals are light, but fully up to the wants of the trade. Prices are steady, with sales of 110 bbls. at 32½c., and 64 bbls. at 33c.

AUGUST 1.

Menhaden oil has not come to hand since our last, and the receipts during July are probably as small as we ever knew them. The demand here is not large, however, and we do not know that better than 32½ @ 33c. would be paid. The catch in the Sound is only fair, and the Maine fishing thus far quite poor. The Boston market is poorly supplied, and are bidding 34c., delivered, with sales of several lots at the Connecticut factories at 32½ @ 33c.

AUGUST 8.

Menhaden oil is very much stronger here, though not much higher on actual business. The Maine catch being light, New Bedford and Boston dealers have had to go direct to the Long Island and Sound factories and buy, and we hear that they have bought at 32½ @ 33½c. at the factory, equal to 35c. delivered. In consequence of these sales we have had very little oil here, and these lots are promptly taken on arrival. The sales reported are 200 bbls. Barren Island at 33½c., and two lots of 50 bbls. each at 33c.

AUGUST 15.

Menhaden oil has not come to this market to any extent of late, and the price is higher. There have been few sales for want of stock. We heard that 175 bbls. were placed at 34 @ 34½c., with 35c. now bid, and possibly 36c. will be paid. Sales are reported in the East as high as 40c. Bleached oil is higher also, as well as all the other grades.

AUGUST 22.

Menhaden oil is not coming in, and the price is very much higher, with one sale of 100 bbls. prime at 36c., with other sales of 250 bbls. reported at 35c., which price will now be paid.

AUGUST 29.

Menhaden oil scarce and higher, with exceedingly small arrivals, the Maine fishery being very poor, and Eastern dealers drawing their supplies from the Sound catch. We are receiving very little here, and our dealers are short of stock. The sales reported since our last are 128 bbls. brown at 36c., and 75 bbls. select light at 38c. Strained and bleached are higher.

SEPTEMBER 5.

Menhaden oil is scarce, and higher prices would be paid for lots, but there are none arriving. It is difficult to say what could be obtained, but probably 38c., though some dealers say they would not pay more than 35c. If the present scarcity continues prices will go above 40c. very soon.

SEPTEMBER 12.

Eastern buyers are visiting the Long Island Sound factories, picking up all the menhaden oil they can find. Makers are, however, generally holding for higher prices, expecting to get 45c. soon. One lot has been sold equivalent to 42c. delivered.

SEPTEMBER 19.

Menhaden oil is scarce here, and there are no sales for want of stock; prices are nominal, but a lot would probably bring somewhere near 45c. if nice. We hear that 500 bbls. sold in New Bedford at 45c. cash, and 300 bbls. at works on Long Isl'd at 43c. Bleached oils are higher, and 250 bbls. sold at 50c.

SEPTEMBER 26.

Menhaden oil is not to be had, and though a higher price would be paid, we do not know what it would be. It is hoped that fishing will yet be good before cold weather sets in. There has been a good demand for bleached, which is now higher also; sales were made of 100 bbls. at 51c., and 50 bbls. at 52c.

OCTOBER 3.

Menhaden oil is still very firm, and the lots coming in are readily taken at high prices. The last catch of fish at Maine was good, but all except two factories were closed, and the make was consequently small. The fishermen are now at Provincetown, awaiting the fish as they go down the coast. It is hoped that the catch may yet be good, but it cannot make up the deficiency. The sales reported here are 215 bbls. at 44c., 100 bbls. at 44c., 100 bbls. resold at 44c., and 120 bbls. at 44c. cash; in New Bedford, 300 bbls. Maine at 45c., 250 bbls. at 45c., and 100 bbls. at 45c. Bleached is firmer and in good demand, with sales of 250 bbls. here at 52c.

OCTOBER 10.

Menhaden oil is still in limited supply and firm in price, though we are reported sales by one party of 300 bbls. at 43 @ 44c. We know, how-

ever, of sales of 150 bbls. here at 44c., and hear that there has been some business done in the East at 47c.

A letter from New Haven, dated October 8, 1877, says: "The stormy weather of a portion of last week reduced what would have been a small catch of menhaden anyway to a very meagre amount. They ran one grade better than previously, and it is hoped a radical change of quality is very near. Fishermen in the usual quality of their 'devotions' are praying for quiet weather."

OCTOBER 17.

Menhaden oil still rules very firm with few lots to be had. There have been some sales of Sound made at 44 @ 45c., with none offering at the close that we hear of. In reference to the catch we have the following under date of October 15, 1877:

"There were but two fishing days last week on Long Island Sound, owing to winds. The catch was good as to quantity, but still poor in quality. The season lasts but about a month longer, and impatience is felt for the appearance of fat fish."

OCTOBER 24.

Menhaden has come to hand more freely the past week than at any time this season, and indirectly we hear that fishing at Provincetown and vicinity is good; that several of the Maine factories are running on the fish their boats catch there, and that there is a possibility of the deficiency being yet nearly made up, the fish being very fat. The stocks here in the hands of dealers are very light, but they also report a very moderate demand, tanners using cod, degreas, and other greases in place of menhaden. There is a cargo of 600 bbls. of Maine oil in, a part of which is reported sold to a dealer at 46c., and sales are said to have been made in New Bedford at as high as 47c. There were sales here, however, of prime light Sound make of 100 bbls. on spot at 45c., and 100 bbls. to arrive at 45c., with the close easy. Bleached is easy, and we do not hear of any late sales; holders ask 52 @ 52½c.

From New Haven, October 20, 1877, a correspondent says:

"We do not hear that a menhaden has been caught this week anywhere west of Massachusetts. It is hoped to be the interval between the change of plays, where the farce ends and the solid piece begins. Fat fish are now looked for daily."

OCTOBER 31, 1877.

Menhaden has been quiet the past week, the lots coming in having mostly been placed before arrival. We only hear of a lot of 75 bbls. choice, which brought 45c., and other lots are offering at this figure.

NOVEMBER 7.

Menhaden oil has been offering more freely, and with buyers' ideas a little lower. Sales have been made of 500 bbls. at 44 @ 45c. Bleached winter is quoted higher by some parties, but can still be had at 52½ @ 53c. Bank and Straits are steady.

NOVEMBER 14, 1877.

Menhaden oil has been in fair request during the past week and par-

cels have been taken at previous figures, and we hear of sales of 250 bbls. Sound oil at $44\frac{1}{2}$ @ 45c., 116 bbls. at $44\frac{1}{2}$ c., 500 bbls. at 45c., and 250 bbls. at 44 @ 45c. The close is rather quiet, as but few lots are offering. Bleached is held at 53 @ 54c., with sales of 50 bbls. at 53c. Banks and Straits quiet and steady at 48 @ 50c.

A correspondent from New Haven, under date of November 12, says: "Fat menhaden were caught the first week in this month, but owing to the strong winds and stormy weather the aggregate was quite small. Last week gave but a small quantity and they were quite poor, about $1\frac{1}{2}$ gall. to the thousand. This week will close most of the fishing unless there is a change in quantity and quality. The fishermen are greatly disappointed in the result of their fall work."

NOVEMBER 21.

Menhaden is strong, as the catch is now said to be about over. There have been sales of 300 bbls. crude at $44\frac{1}{2}$ @ 45c. Bleached is jobbing at 53c., and a lot of 50 bbls. sold at this price, 60 days' time.

NOVEMBER 28.

Menhaden is firm, and prime light oil on spot will bring 45c., at which price we heard of a sale of 100 bbls.; also 228 bbls. to arrive at $44\frac{1}{2}$ c., and 78 bbls. brown, on spot, at $44\frac{1}{2}$ c. Bleached is in fair demand, with prices ruling about steady; 60 bbls. sold at 53c., 60 days.

DECEMBER 5.

Menhaden oil has ruled very firm, and there has been a good demand, with stocks in the hands of the dealers not large. The sales reported are 500 bbls. at 45c., 250 bbls. at 45c., and 280 bbls. dark at 44c. Bleached winter is selling fairly, and we note 150 bbls., at $52\frac{1}{2}$ c., with some now asking an advance.

DECEMBER 12.

Menhaden oil is steady, but very quiet. The offerings are moderate, but buyers are not wanting any, except very choice of the last catch. We do not hear of any sales; prime would bring 45 @ $45\frac{1}{2}$ c., and choice light-colored 46 @ $46\frac{1}{2}$ c. Bleached is steady and in demand, with 100 bbls. reported sold at $52\frac{1}{2}$ c. cash. Bank and Straits are in light demand at former prices.

DECEMBER 19.

Menhaden oil is firm, and the lots coming to hand are readily taken. There was a cargo in last week, about 500 bbls., 150 bbls. of which sold at 44 @ 45c., 100 bbls. were delivered on a contract made early last summer at 33c., and the balance went into store. Bleached sold last week at $52\frac{1}{2}$ c.

DECEMBER 26.

Menhaden oil has been rather quiet, with a few lots coming in. We heard of a sale of 128 bbls. at 44c., but the price generally quoted is 45c. Bleached is steady, with a sale of 50 bbls. reported at $52\frac{1}{2}$ c.

JANUARY 2, 1878.

Menhaden oil has not sold since our last report that we hear of. A lot could not have been sold at its real value. We understand that 45c. is about the price dealers have marked their stock in taking account.

APPENDIX L.

Annual proceedings of the United States Menhaden Oil and Guano Association.

FIRST ANNUAL MEETING.

At a meeting of the menhaden oil and fish guano manufacturers of Maine, Long Island, Connecticut, Rhode Island, and New Jersey, held in New York January 7, an association was formed, to be known as "The United States Menhaden Oil and Guano Association." A constitution and articles of association were adopted.

The meeting organized with R. L. Fowler of Guilford, Conn., as chairman, and Luther Maddocks, of Booth Bay, Me., as secretary. After some discussion a committee on statistics was appointed, with instructions to report as soon as possible. The committee was as follows: Mr. L. Maddocks, Maine; Mr. Church, from Rhode Island; Mr. Price, from Long Island; and Mr. Fairchild, from Connecticut.

Mr. Fairchild, as chairman, reported as follows: Number of factories in operation, 62; amount of capital invested, \$2,388,000; number of fishermen employed, 1,197; number of men employed at factories, 1,169; number of sailing-vessels employed, 383; number of steamers employed, 20; total number of fish caught, 1,193,100 barrels (250 fish to barrel); total of oil made, 2,214,800 gallons; total amount of guano made, 36,299 tons. Stock in hand of manufacturers, 484,520 gallons oil and 2,700 tons guano.

The meeting then voted to appoint a committee on permanent organization and to report a constitution and by-laws. This committee consisted of Mr. J. G. Nickerson, Boston; Mr. Thomas F. Price, Greenport, Long Island, and Mr. H. L. Dudley, New Haven. Their report was accepted and the constitution adopted, and the following officers chosen for the ensuing year: President, Luther Maddocks, of Booth Bay, Me.; vice-presidents, George F. Tuthill, Greenport, Long Island, and R. L. Fowler, Guilford, Conn.; secretary and treasurer, H. L. Dudley, New Haven; executive committee, Luther Maddocks, Booth Bay, Me., David F. Vail, River-head, Long Island, B. F. Brightman, Round Pond, Me.

Constitution and by-laws of the United States Menhaden Oil and Guano Association.

NEW YORK, January 7, 1874.

Whereas the manufacture of menhaden oil and fish guano has become identified as one of the important industries of this country; therefore

Resolved, That we, the manufacturers, with the view of rendering to each other mutual aid and assistance, do hereby form ourselves into an association for this purpose, and to be governed by the following constitution:

ARTICLE 1. This association shall be called the "United States Menhaden Oil and Guano Association."

ART. 2. The officers shall be a president, two vice-presidents, secretary and treasurer, and executive committee.

ART. 3. the president shall preside at all meetings of the association. In the absence of the president either of the vice-presidents may preside. In the absence of all these officers a president shall be chosen *pro tem*.

ART. 4. The secretary shall keep a faithful record of all buisness, transacted at each meeting of the society, and shall notify members of all meetings by written or printed notice.

ART. 5. The treasurer shall have charge of all funds belonging to the association, and shall pay them out only by order of the executive committee.

ART. 6. The executive committee shall consist of three, of which the president shall be one. They shall have power to raise money to meet the expenses of the association by an equitable assessment of each member, and shall have a general supervision of all the affairs and business of the association not otherwise provided for.

ART. 7. The annual meeting of this association shall be held on the 2d Wednesday of January annually. The place of meeting shall be determined by a majority of the executive committee, and a notice shall be mailed by the secretary to each member of the association fifteen days previous to the time of meeting.

ART. 8. Special meetings of the association may be called at any time by the executive committee, and upon a written request signed by five members addressed to the president. Notice of all such meetings shall be mailed by the secretary to each member ten days previous to the time of meeting.

ART. 9. Any person, or any member of any company, engaged in the manufacture of menhaden oil and fish guano in the United States may become a member of the association by subscribing to this constitution and these articles of association.

ART. 10. Each firm or company shall be entitled to but one vote at meetings of the association.

ART. 11. The officers of this association shall be chosen annually by ballot, and shall hold their office for one year or until others are chosen.

ART. 12. This constitution may be amended at any annual meeting, or special meeting called for that purpose, by a two-thirds vote of the members present.

ART. 13. Nine members shall constitute a quorum, but a less number may adjourn.

SECOND ANNUAL MEETING—1874.

The report of the statistical committee was as follows:

Number of factories in operation	64
Number of men employed at factories.....	871
Number of sail vessels	283
Number of steamers.....	25

Number of men employed in fishing	1, 567
Amount of capital invested	\$2, 500, 000
Number of fish caught	492, 878, 000
Estimated in barrels	1, 478, 634
Tons of guano made	50, 976
Gallons of oil made	3, 372, 837
Guano on hand January 13, 1875	tons.. 5, 200
Oil on hand January 13, 1875	gallons.. *648, 000

THIRD ANNUAL MEETING—1875.

The third annual meeting of this association was held at the Aldrich House, Providence, R. I., January 12, 1876. The following-named manufacturers were present: R. L. Fowler, Connecticut; L. Maddocks, Maine; F. E. Colburn, Connecticut; E. T. Dublois, Rhode Island; George W. Miles, Connecticut; B. F. Brightman, Maine; Daniel T. Church, Rhode Island; William J. Brightman, Rhode Island; Isaac Brown, Rhode Island; John Southworth, Rhode Island; Frederick Gallup, Connecticut; B. F. Gallup, Connecticut; S. Jones, New York; V. Koon & Son, New York; J. H. Bishop, Connecticut, William Holmes, Connecticut; Job T. Wilson, Massachusetts; H. L. Dudley, Connecticut.

The president, R. L. Fowler, being in the chair, the minutes of the last meeting were read and approved.

The treasurer's report was read, examined, and accepted.

The committee on statistics reported as follows:

Number of factories in operation in 1874	64
Number of factories in operation in 1875	60
Decrease	4
Number of men employed in 1874	2, 438
Number of men employed in 1875	2, 633
Increase	*195
Number of sailing-vessels employed in 1874	283
Number of sailing-vessels employed in 1875	304
Increase	21
Number of steam-vessels employed in 1874	25
Number of steam-vessels employed in 1875	39
Increase	14

* The full records of this meeting were not to be obtained.

Number of fish caught in 1874	492, 878, 000, or 1, 642, 927 barrels.
Number of fish caught in 1875	563, 327, 000, or 1, 877, 767 barrels.
Increase	70, 449, 000, or 734, 840 barrels.
Number of gallons of oil made in 1874	3, 372, 847
Number of gallons of oil made in 1875	2, 681, 487
Decrease	691, 360
Number of tons of guano made in 1874	50, 976
Number of tons of guano made in 1875	53, 625
Increase	2, 649
Amount of capital invested in 1875	\$2, 500, 000
Amount of capital invested in 1876	2, 650, 000
Increase	150, 000
Number of gallons of oil held by manufacturers January 12, 1875	648, 000
Number of gallons of oil held by manufacturers January 12, 1876	125, 000
Number of gallons in manufacturers' hands less than at annual meeting in 1875	523, 000
Number of tons guano held by manufacturers January 12, 1875	5, 200
Number of tons guano held by manufacturers January 12, 1876	1, 850
Number of tons guano held by manufacturers, less than in 1875	3, 350

The following officers were elected for the ensuing year: President, R. L. Fowler, Guilford, Conn.; first vice-president, B. Frank Gallup, Groton, Conn.; second vice-president, Daniel T. Church, Tiverton, R. I.; secretary and treasurer, H. L. Dudley, New Haven, Conn.; executive committee, R. L. Fowler, Connecticut, V. Koon, New York, Isaac Brown, Rhode Island.

A letter from the Hon. S. L. Goodale, of Saco, Me., was presented to the association by Mr. Maddocks, and read by the secretary. It was listened to with much pleasure and interest, and the secretary was directed to incorporate the substance of the letter in his report. It stated that the writer had discovered a process for making, from the juices of

the menhaden, an extract similar to the article now so extensively manufactured and sold as "extract of beef," and that the juices of the menhaden were better for this purpose than those of any other fish yet tested. Mr. Goodale is confident that "now, for the first time, is the true function of this fish in the economy of nature recognized," and that the time is not far distant when the *principal* product sought for from it will be its concentrated juices, while the quantity of oil and scrap obtained will not be noticeably diminished, as this process utilizes that portion of the fish which has formerly been, and by the present mode of manufacture is still, allowed to go to waste. In support of his discovery, Mr. Goodale quotes from a letter received from that eminent and reliable chemist, Prof. Samuel W. Johnson, of Yale College, as follows: "I cannot doubt that the fish extract is entirely new, and, as food, is equal to beef extract in all respects (except, possibly, in the matter of iron), and, if put into the market in proper shape, would shortly share the patronage now so largely bestowed on beef extract." It is hoped that some practical test of this discovery will soon be made.

Some interesting facts and figures were presented by Messrs. Madocks, Brightman, and Church, upon the shrinkage of fish during the process of manufacture, and in the difference in yield of scrap from the same number of fish at different factories.

An article was read from the New York Commercial Bulletin giving some facts concerning the foreign and domestic trade in fish scrap. Some four thousand tons of scrap were stated to have been recently shipped to Liverpool and Queenstown, as the result of some experimental shipments made last year. There is also a growing demand in the West Indies. It is evident that both the foreign and domestic demand for fish scrap is rapidly increasing.

The following resolution was freely discussed and unanimously passed:

"*Resolved*, That all guano or scrap manufactured by members of this association shall be sold at the weight taken at the factory of the seller."

Particular attention is called to the above resolution, as it is a matter of no little importance whether the scrap is weighed at the place of shipment or place of delivery, and there is no doubt the buyers of scrap will see the justice of this resolution and readily accede to it. All present pledged themselves to rigidly adhere to the resolution.

An adjourned meeting of the association will be held at the Aldrich House, Providence, R. I., on Wednesday, April 5, 1876, at 10 o'clock a. m.

H. L. DUDLEY, *Secretary*.

NEW HAVEN, *January 15, 1876.*

FOURTH ANNUAL MEETING.

The fourth annual meeting of this association was held at the United States Hotel, New York, January 10, 1877, the president, R. L. Fowler, in the chair. The minutes of the last meeting were read and accepted; the treasurer's report was read and accepted; the committee on statistics reported as follows:

Number of factories in operation in 1876	64
Number of factories in operation in 1875	60
Gain	4
Number of sail-vessels employed in 1876	320
Number of sail-vessels employed in 1875	304
Gain	16
Number of steam-vessels employed in 1876	46
Number of steam-vessels employed in 1875	39
Gain	7
Number of men employed in 1876	2,758
Number of men employed in 1875	2,633
Gain	125
Amount of capital invested in 1876	\$2,759,000
Amount of capital invested in 1875	2,650,000
Gain	100,000
Number of fish caught in 1876	512,450,000
Number of fish caught in 1875	563,327,000
Loss	50,877,000
Estimated by barrels in 1876	1,535,885
Estimated by barrels in 1875	1,877,767
Loss	341,882
Number of gallons of oil made in 1876	2,992,000
Number of gallons of oil made in 1875	2,681,487
Gain	310,513

Number of tons of guano made in 1876	51, 245
Number of tons of guano made in 1875	53, 625
Loss	2, 380
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Number of gallons of oil held by manufacturers January 10, 1877	264, 000
Number of gallons of oil held by manufacturers January 12, 1876	*125, 000
In excess of amount held January, 1876	139, 000
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Number of tons of guano held by manufacturers January 10, 1877	7, 275
Number of tons of guano held by manufacturers January 12, 1876	5, 200
In excess of amount held January 12, 1876	2, 075
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The report of the committee on statistics was accepted. This report is believed to be the most accurate and full of any yet obtained by the association, and the committee are much indebted to Mr. Jasper Pryer for information received and assistance rendered. The officers were chosen for the ensuing year by ballott, and were as follows: President, R. L. Fowler, Guilford, Conn.; first vice-president, Daniel T. Church, Tiverton, R. I.; second vice-president, B. Frank Gallup, Groton, Conn.; secretary and treasurer, H. L. Dudley, New Haven, Conn.; executive committee, R. L. Fowler, Guilford, Conn., George F. Tuthill, Greenport, N. Y., B. F. Brightman, Round Pond, Me.

Application for admission as members was made by persons not manufacturers of, but dealers in, oil and guano. After some discussion it was decided to postpone any action upon the matter until the next annual meeting, notice of which is to be given to the applicants by the secretary. Hon. S. L. Goodale, of Saco, Me., made an address upon the food properties of the menhaden, and produced samples of an extract obtained from menhaden, which has been pronounced by the most eminent scientific authorities quite equal in nutritious properties to the well-known beef extract. The menhaden extract was sampled by the association, and not unfavorably compared with the beef extract, a sample of which was also on trial. It is hoped that the successful development of this new branch of the menhaden industry is not far distant. A vote of thanks was given Mr. Goodale for his address.

* N. B.—In the estimate of oil held by manufacturers, January 12, 1876, oil at New Bedford was not included, therefore the stock held January, 1877, by manufacturers, is about the same as that of January, 1876; but it was deemed best to include in this and future reports all oil held by manufacturers, or for their account, and thus present a full report of all the oil unsold, or to be put into market, by manufacturers.

Encouraging statements in regard to foreign demand for fish guano were made by Mr. Pryer, representing Messrs. Jed. Frye & Co., shipments having been made to Europe by this firm during the past season. More attention is being given to the drying of the fish scrap, as in that form all of our product may be exported at fair prices. A communication from a gentleman engaged in foreign trade was read by Mr. George F. Tuthill, stating that 30,000 tons of the dried fish scrap could be sold annually in Italy, and parties were ready to make contracts for full cargoes. It is probable that a large quantity will be sent abroad the coming season.

After some discussion upon fixing a time and place for the next meeting, a vote was passed amending article 7 of the constitution. As amended the article reads as follows: "Article 7. The annual meeting of this association shall be held in January, annually, and the time and place of meeting shall be determined by a majority of the executive committee, and a notice shall be mailed by the secretary to each member of this association fifteen days previous to the time of meeting." As the meeting of the Maine association was held in Boston the day before our meeting, our attendance was small. Another year, probably, the time and place of meeting of this association will be arranged to suit the convenience of a large number of its members.

H. L. DUDLEY, *Secretary*.

FIFTH ANNUAL MEETING.

The fifth annual meeting of this association was held at the City Hotel, Providence, R. I., January 9, 1878, the president, R. L. Fowler, in the chair. In the absence of the secretary, Luther Maddocks, esq., was appointed secretary *pro tempore*.

The minutes of the last meeting were read and approved. Treasurer's report read and accepted. The officers elected for the ensuing year were: President, R. L. Fowler, Guilford, Conn.; first vice-president, Daniel T. Church, Tiverton, R. I.; second vice president, B. Frank Gallup, Groton, Conn.; secretary and treasurer, H. L. Dudley, New Haven, Conn.; executive committee, R. L. Fowler, Guilford, Conn., Isaac Brown, Tiverton, R. I., George W. Miles, Milford, Conn.

Voted, To assess each member one dollar, the same to be collected by the treasurer.

Isaac Brown, The Narragansett Oil Company, and J. G. White were admitted to membership in the association.

Voted, That the next annual meeting of the association be held in New York City.

Voted, That any firm or company belonging to the association may be represented at its meetings by proxy.

The committee on statistics reported as follows:

Number of factories in operation in 1876	64
Number of factories in operation in 1877	56
Loss	8
Number of sail-vessels employed in 1876	320
Number of sail-vessels employed in 1877	270
Loss	50
Number of steam-vessels employed in 1876	46
Number of steam-vessels employed in 1877	63
Gain	17
Number of men employed in 1876	2, 758
Number of men employed in 1877	2, 631
Loss	127
Amount of capital invested in 1876	\$2, 750, 000
Amount of capital invested in 1877	2, 047, 612
Loss	*\$702, 388
Number of fish caught in 1876	512, 450, 000
Number of fish caught in 1877	587, 624, 125
Gain	75, 174, 125
Number of fish caught, estimated by barrels, in 1876	1, 708, 163
Number of fish caught, estimated by barrels, in 1877	1, 958, 747
Gain	250, 581
Number of gallons oil made in 1876	2, 992, 000
Number of gallons oil made in 1877	2,426,589
Loss	566, 589
Number of tons guano made in 1876	51, 245
Number of tons guano made in 1877	55, 444
Gain	4, 199

* The difference in capital reported in 1877 from 1876, is mainly represented by factories not in operation, and is more properly idle capital than "loss."—SECRETARY

In 1877, 5,700 tons of dried scrap were made by the oil and guano manufacturers.

Number of gallons oil held by manufacturers January 10, 1877	264, 000
Number of gallons oil held by manufacturers January 9, 1878	86, 000
Amount less than in 1877.....	178, 000
Number of tons guano held by manufacturers January 10, 1877	7, 275
Number of tons guano held by manufacturers January 9, 1878	1, 640
Amount less than in 1877.....	5, 635

After the report had been accepted and committee discharged, the secretary *pro tempore* read a paper from Dr. Maylert on the subject of scrap-drying. Remarks upon the same subject were also made by Professor D'Homergue.

Prof. S. L. Goodale then addressed the association upon his method of extracting or liberating the oil from fish scrap. A general discussion then took place upon the subject of scrap-drying, and the several new methods proposed to accomplish the object. Much attention is being given to this important matter, and the amount of scrap dried the past season was probably double that of any former year, and as the demand is increasing each year, and the saving in ammonia in the dried material is so large an item, it is hoped that some simple, inexpensive method will soon be found for accomplishing the desired results. The meeting of the association was quite fully attended, and the most interesting yet held.

The statistics gathered are believed to be the most accurate of any yet obtained. The stocks on hand, of both oil and guano, are very small. The outlook for the coming season is quite favorable, and better prices will doubtless be obtained than for the past few years. Ammoniacal matter is scarce, and in demand at good prices.

H. L. DUDLEY, *Secretary.*

APPENDIX M.

ANNUAL REPORTS OF THE ASSOCIATION OF MENHADEN OIL AND GUANO MANUFACTURERS IN THE STATE OF MAINE.

First annual report, for the year 1873.

Names and post-office address.	Amount of capital invested.		Number of fishermen employed.	Number of vessels.	Number of steamers.	Average number of men at works.	Number of barrels of fish taken at works.	Number of barrels of fish sold for bait.	Number of gallons of oil made.	Tons of crude guano made.
	Factory.	Fish-gear.								
L. Brightman & Sons, Round Pond, Me	\$30,000	\$60,000	80	5	3	30	49,000	100	135,000	1,500
Judson, Tarr & Co., Penaquid, Me	50,000	60,000	60	6	4	27	61,000	200	175,000	1,800
Albert Gray & Co., Round Pond, Me	14,000	14,000	15	1	1	17	25,000	100	70,000	750
Josiah Church & Co., Round Pond, Me	60,000	60,000	60	4	4	50	86,000	.....	250,000	2,100
Gallup, Morgan & Co., East Booth Bay, Me	12,000	7,000	27	3	0	9	92,000	500	55,000	680
W. A. Wells & Co., South Bristol, Me	7,000	20,000	25	2	1	15	92,913	270	62,000	700
Gallup & Hines, East Booth Bay, Me	12,000	10,000	36	3	0	10	15,000	400	45,000	470
Kenniston, Cobb & Co., Booth Bay, Me	12,000	15,000	40	4	0	11	15,000	327	53,800	615
Atlantic Oil Company, Booth Bay, Me	32,000	33,000	60	6	1	24	43,000	500	120,000	1,800
Round Pond Oil Works, Round Pond, Me	12,000	4,000	30	3	0	15	16,500	.....	43,255	450
Bristol Oil Works, Round Pond, Me	10,000	4,000	20	0	2	15	22,000	.....	55,000	600
Suffolk Oil Works, East Boothbay, Me	25,000	20,000	60	5	1	16	41,000	600	120,000	1,300
Loud's Island Oil Works, Round Pond, Me	2,500	4,000	20	2	0	10	8,000	.....	20,000	200
Totals	278,500	335,000	533	38	17	249	429,413	2,977	1,304,035	12,965

Second annual report, 1874.

Names and post-office address.	Amount of capital invested.		Number of fishermen employed.	Number of vessels.	Number of steamers.	Average number of men at works.	Number of barrels of fish taken at works.	Number of barrels of fish sold for bait.	Number of gallons of oil made.	Tons of crude guano made.
	Factory.	Fish-gear.								
L. Brightman & Son, Round Pond, Me.	\$30,000	\$60,000	80	3	4	40	82,000	.....	260,000	8,600
Judson, Farr & Co., Penaquid, Me.	60,000	60,000	50	1	4	30	67,000	2,000	200,000	2,150
Albert Gray & Co., Round Pond, Me.	20,000	35,000	24	1	2	30	40,000	.....	153,665	1,350
Joseph Church & Co., Round Pond, Me.	65,000	55,000	70	3	4	70	138,000	200	450,000	4,000
Gallup, Morgan & Co., East Boothbay, Me.	5,000	19,000	27	2	1	13	29,472	500	88,204	.....
W. A. Wells & Co., South Bristol, Me.	10,000	25,000	20	2	1	16	30,000	.....	93,000	900
Gallup & Holmes, East Boothbay, Me.	15,000	10,000	50	4	0	12	25,000	500	71,000	700
Kenniston, Cobb & Co., Boothbay, Me.	15,000	15,000	50	5	0	10	28,389	1,000	84,108	850
Atlantic Oil Company, Boothbay, Me.	40,000	60,000	60	3	3	20	64,000	3,000	193,000	2
Round Pond Oil Works, Round Pond, Me.	15,000	3,000	30	6	0	15	27,000	.....	87,000	850
Bristol Oil Works, Round Pond, Me.	8,000	12,000	30	0	2	16	33,000	100	102,000	800
Snifolk Oil Works, East Boothbay, Me.	25,000	30,000	50	4	1	16	29,000	2,900	83,000	950
Lord's Island Oil Works, Round Pond, Me.	5,000	3,000	20	2	0	12	15,000	.....	44,000	500
E. A. Friend, Brooklin, Me.	3,000	3,500	10	1	0	14	8,000	.....	22,000	205
Totals	316,000	390,500	561	37	22	304	621,861	10,400	1,931,037	19,295
Increase over 1873	37,500	55,500	28	1 dec.	5	45	192,448	7,423	726,952	6,350

Third annual report, 1875.

Names and post-office address.	Amount of capital invested.		Number of fishermen employed.	Number of vessels.	Number of steamers.	Average number of men at works.	Number of barrels of fish taken at works.	Number of barrels of fish sold for bait.	Number of gallons of oil made.	Tons of crude guano made.
	Factory.	Fish-gear.								
Joseph Church & Co., Round Pond, Me.	\$25,000	\$60,000	100	2	5	60	153,000	.....	446,000	4,500
Tutbill & Co., South Bristol, Me.	12,000	16,000	20	1	1	11	16,353	335	48,428	500
J. J. G. Nickerson & Co., Hodgdon's Mills, Me.	40,000	50,000	80	3	3	13	43,625	1,332	114,380	1,375
John Hastings, Round Pond, Me.	15,000	8,000	30	.....	.....	14	14,000	500	37,000	400
Gallup & Holmes, Hodgdon's Mills, Me.	20,000	30,000	50	2	2	18	32,000	600	86,000	900
Kenniston & Cobb, Boothbay, Me.	15,000	10,000	50	5	.....	12	21,353	1,000	56,656	714
Fowler & Foot, South Bristol, Me.	18,000	18,000	36	.....	1	18	16,000	800	36,400	450
George W. Miles & Co., South Bristol, Me.	25,000	32,000	50	1	2	15	25,000	.....	71,000	850
Wells & Co., South Bristol, Me.	10,000	30,000	32	2	2	17	25,000	300	76,000	510
Gallup & Morgan, Hodgdon's Mills, Me.	11,000	20,000	37	2	.....	17	29,545	865	75,017	1,016
Loud's Island Oil Company, Round Pond, Me.	4,000	4,000	20	2	.....	9	12,300	.....	30,000	400
L. Brighthouse & Son, Round Pond, Me.	30,000	60,000	96	3	4	45	83,000	1,000	200,000	5,000
Albert Gray & Co., Round Pond, Me.	25,000	25,000	40	1	3	30	53,000	.....	135,000	1,680
Bristol Oil Company	8,000	14,000	30	2	1	20	24,000	.....	70,000	800
Round Pond Oil Company	13,000	3,000	30	3	.....	16	18,000	.....	45,000	550
Atlantic Oil Company, Boothbay, Me.	60,000	80,000	.....	.....	6	25	56,000	4,000	140,000	2,000
Job T. Wilson, Blue Hill, Me.	4,000	20,000	10	.....	1	13	10,400	.....	25,000	230
Totals	397,000	482,000	771	36	31	373	635,771	10,752	1,514,881	19,395
Gain over 1874	81,000	91,500	210	.....	9	69	.....	.....	.....	100
Loss from 1874	.....	.....	.....	1	.....	.....	13,910	352	416,156	.....

Fourth annual report, 1876.

Names and post-office address.	Amount of capital invested.		Number of fishermen employed.	Average number of men at work.	Number of steamers.	Number of vessels.	Number of barrels of fish taken at works.	Number of barrels of fish sold for bait.	Number of gallons of oil made.	Tons of crude guano made.
	Factory.	Fish-gear.								
Joseph Church & Co., Round Pond, Me.	\$80,000	\$75,000	120	50	7	2	201,000	150	600,000	6,000
Atlantic Oil Company, Booth Bay, Me.	60,000	75,000	60	25	6		51,878	1,800	139,000	1,595
C. H. Tuttle & Co., South Bristol, Me.	10,000	28,000	30	14	6	1	27,960		89,000	1,835
Albert Gray & Co., Round Pond, Me.	15,000	30,000	50	30	3	1	45,000	150	129,000	1,300
George W. Miles & Co., South Bristol, Me.	25,000	32,000	25	20	3		37,000		124,700	1,131
Wells & Co., South Bristol, Me.	10,000	30,000	30	18	2		30,000		87,000	1,600
Gallup, Morgan & Co., East Booth Bay, Me.	10,000	23,000	35	15	2	1	34,763		111,018	1,190
Gallup & Holmes, East Booth Bay, Me.	18,000	36,000	38	18	3		40,900		132,555	1,830
Fowler, Foote & Co., South Bristol, Me.	18,000	30,000	34	14	2	3	26,530	2,832	83,000	1,855
L. Brightman & Son, Round Pond, Me.	50,000	60,000	60	40	4	2	48,000		146,000	1,430
Round Pond Oil Company, Round Pond, Me.	8,000	4,000	40	15		4	22,600	2,000	72,000	600
Bristol Oil Company, Round Pond, Me.	8,000	8,000	30	13		4	27,653	200	80,000	800
Suffolk Oil Company, East Booth Bay, Me.	40,000	40,000	50	15	1	2	26,916		82,500	850
Kenniston, Cobb & Co., Booth Bay, Me.	15,000	10,000	50	17	1	4	14,474	300	39,500	453
Pemquid Oil Company, Pemquid, Me.	50,000	60,000	50	40	4		60,000		180,000	2,000
Brown's Cove Company, Round Pond, Me.	10,000	5,000	30	15		3	5,000	1,000	15,000	175
Loud's Island Company, Round Pond, Me.	4,000	4,000	20	12		3	13,000		28,000	
Total	431,000	552,000	758	371	43	29	769,000	8,492	2,143,273	21,414
Gain over 1875	34,000	70,000		2	12		73,229	2,320	628,392	2,019
Loss from 1875			13			7				

Fifth annual report, 1877.

Names and post-office address.	Amount of capital invested.		Number of fishermen employed.	Number of vessels.	Number of steamers.	Average number of men at works.	Number of barrels of fish taken at works.	Number of barrels of fish sold for bait.	Number of gallons of oil made.	Tons of crude guano made.
	Factory.	Fish-gear.								
Joseph Church & Co., Round Pond, Me.....	\$80,000	\$120,000	140	2	8	60	152,000	760	365,781	5,400
Albert Gray & Co., Round Pond, Me.....	15,000	40,000	50	1	4	30	27,000	300	44,000	800
Gallup & Holmes, East Booth Bay, Me.....	20,030	50,000	60	0	4	20	51,817	100	121,000	1,500
Gallup, Morgan & Co., East Booth Bay, Me.....	18,812	25,800	28	0	2	15	23,760	150	47,880	700
Bristol Oil Works, Round Pond, Me.....	15,000	20,000	40	4	3	15	22,500	200	53,500	600
Round Pond Oil Works, Round Pond, Me.....	15,000	6,000	50	0	0	15	5,590	0	8,500	150
Tudhill, French & Co., South Bristol, Me.....	10,000	32,000	30	0	3	13	27,176	3,237	65,000	800
Loud's Island Oil Works, Round Pond, Me.....	12,000	13,000	42	2	1	12	9,600	0	15,680	275
Maddocks Oil Works, Booth Bay, Me.....	60,000	70,000	68	0	6	20	51,610	1,500	118,000	1,600
Peniquid Oil Works, Bristol, Me.....	50,000	50,000	65	0	5	30	61,031	1,508	130,000	1,900
Porter, Foote & Co., South Bristol, Me.....	18,000	24,000	42	3	2	13	17,721	340	39,872	562
Suffolk Oil Company, East Booth Bay, Me.....	30,070	15,000	28	1	2	19	24,330	1,200	51,000	740
George W. Miles & Co., South Bristol, Me.....	25,000	34,050	39	0	2	15	20,000	1,000	45,000	725
Brown's Cove Company, Round Pond, Me.....	15,000	8,000	0	0	0	0	0	0	0	0
Keniston, Cobb & Co., Booth Bay, Me*.....	15,000	10,000	40	0	3	12	19,200	500	40,000	562
Wells & Co., South Bristol, Me.....	15,000	45,000	0	0	0	0	0	0	0	0
L. Prigittman & Son, Bristol, Me.....	26,000	60,000	0	0	0	0	0	0	0	0
South Saint George Oil Works, South Saint George, Me.....	26,040	11,000	26	0	2	12	13,000	60	21,000	352
Total.....	459,812	623,800	727	13	48	300	557,145	10,735	1,166,213	16,606
Gain over 1876.....	28,812	71,800	0	0	0	0	0	0	0	0
Loss from 1876.....	0	0	31	16	5	71	151,855	2,364	977,000	4,748

* Not operated this season.

† Not operated; business changed to drying scrap.

APPENDIX N.

STATEMENTS OF CORRESPONDENTS.

These statements are given in the words of the correspondents, being answers to the circular reproduced in Appendix A. The numbers of the answers correspond to those of the questions in the circular. All the statements included in this appendix have been reviewed in the main report. The commission does not necessarily indorse them.

1. *Statement of W. H. Sargent, Castine, Me., January 26 and December 28, 1874.*

1. Menhaden and pogy, interchangeably.
2. Most abundant.
3. Not so numerous in creeks, coves, inlets, &c., but on the coast, outside of small bodies, it is not decreased.
4. Friend & Co., 25,000 barrels; Allen & Co., 15,000; others, 85,000. In the years from 1863 to 1868, some years 500,000 barrels were taken.
5. It does; especially around and near shores.
6. About the 25th of May. Main body arrives about the middle of June. The last are largest and fattest, usually. Usually two principal schools; the first large school, June 15; the last, September 1 to 10.
7. Swim high. Always make their arrival known by their ripple.
8. Come from the south, between Cape Cod and Cape Sable. Usually first seen just outside of headlands; and as they come into bays, rivers, &c., the main body breaks up.
9. Their appearance is certain. More abundant some seasons. Some seasons they are abundant on the coast of Massachusetts and scarce on the coast of Maine. No two give reasons alike.
10. Undoubtedly catching by any method tends to frighten them; but running refuse water and other refuse from the fish does more harm.
11. They follow the tide in and out creeks, coves, &c.
12. They seem to prefer the still waters of our bays, coves, &c.
13. They are a surface fish, but are sometimes caught thirty feet below.
14. I judge that it does, as they go south on the approach of cold weather.
15. The fish of the same school are uniform in size; some schools larger than others.
16. I have never seen them or heard of them.
17. They usually leave in October. I have known them plenty in November, but not often. I think they leave mostly together; some schools linger.
18. Outside route. General course south.
19. Have no established opinion.

20. They seldom take bait ; very small fish are found in them.

22. Cannot ; I think they are mixed indiscriminately.

32. Large quantities are devoured by sharks, horse-mackerel, whales, porpoises, and other fish of prey.

34 and 35. Gill-nets and seines. Gill-nets are from 30 to 80 feet long, and from 7 to 10 feet deep ; seines are from 50 to 100 fathoms in length, and 5 to 15 fathoms deep.

36. All kinds and sizes. Seine-boats are uniform in size and build ; they have no deck. About 35 feet long and 15 feet beam.

37. Two men can manage nets ; a seine requires from 10 to 15.

38. When fish are plenty, nothing but darkness interrupts.

39. They are not, except in shoal-water places, where they are taken at high tide.

40. They "school" best in calm weather ; consequently more easily taken.

41. I should judge there were 75 vessels of all sizes employed, and from four to five hundred men and boys. Very many who live on the shores fish with nets, tending their nets with small boats, hardly going out of sight of their homes for the season.

42. Nearly all are pressed for the oil ; many are used for fish-bait ; mostly shipped to Boston.

43. There are two or three factories owned by Rhode Island and New York parties, not worked so much now as formerly. R. A. Friend & Co., of Brooklin, are the largest resident manufacturers, but there are about one hundred smaller or private concerns who carry on the business in connection with other business.

44. The aggregate, 1,625 barrels. Friend, about 700 barrels ; Chatto, 350 barrels.

46. Large factories, steam ; smaller ones, the common bed-screw.

47. Slivered, they are worth, put up, about \$6 per barrel ; in 1863 they were worth \$4 ; prices vary with the quantity.

48. When poor, July, 200 ; very poor, 1st June, 250 ; fat, August, 150 ; very fat, October, 100.

49. About one ton of scrap is obtained in making three barrels of oil.

50. Three quarts is the least I ever knew ; from the first school.

51. Six gallons is the most I ever knew ; from the last school.

52. Yes.

53. The first oil made in this region was made by a man named Bartlett, residing on an island in the town of Bluehill, Hancock County, Maine. About the year 1837 he sent a small phial-full to Boston to have it tested. Meeting with encouragement, he commenced in a small way to manufacture by setting a common iron kettle over a fire, filling the kettle with fish, and with a strong cover under a heavy beam, "cider-press" fashion, pressing the oil into a vat. From that time the manufacture increased fast in this section. For about twenty years gill-nets were used exclusively for taking the fish.

54. Boston.

55. Much is used by farmers in the vicinity of its manufacture, but a larger quantity is shipped to Boston, New York, and Baltimore.

56. Generally, I think, for lubricating purposes.

57. In 1873 and four previous years, from 35 to 46 cents a gallon. In 1862, \$1.40 a gallon.

58. It is certain that they have diminished on this coast.

2. *Statement of J. C. Condon, Belfast, Me. Communicated by Marshall Davis, deputy collector, Belfast, Me.*

Your circular, addressed to this office, making inquiries relative to a species of fish found here and called by us pogy, was duly received, and I have the honor to return to you the following answers to your questions, the most of which I will here state were obtained from Mr. J. C. Condon, of this place, who for some years has been engaged to some extent in catching the fish and manufacturing the pogy oil.

1. Your first question I have already answered. We call them pogy.
2. The fish are quite abundant here.
3. Their numbers have diminished.
4. Two thousand barrels of fish in this (Castine) district.
5. It does not appear to, here.
6. The first of June are first seen; most abundant the last of June and into July; come in schools. The second school usually comes ten days later than the first, and the fish are larger, the first being the younger fish.
7. They swim near the surface and make a ripple on the water.
8. They follow the coast from the south.
9. They come every year, but some years later than others.
10. Much fishing with nets would frighten them farther from the shore.
11. Will school out with the ebb, and in with flood.
12. Inside schools come up into the bays near the shore and outside schools play from Portland to Mount Desert. Inside schools are younger and smaller fish.
13. The depth of water makes no difference, as they swim near the surface.
14. They seek warmer water in fall and winter.
15. They breed south and do not reach here until two or three years old.
16. No fish are found here younger than two or three years.
17. They leave in October and November in a body.
18. Follow the coast southerly.
19. On the southern coast.

20. The most that is found in them that seems to be their food, is a small seedlike-looking substance called by fisherman brit.

21. They spawn in southern waters, it is supposed.

22. They go in schools, and not in pairs.

23. We cannot answer that here.

24. We presume warmer than the water here.

25. In shallow water it is supposed.

31. A sort of spider is found on the back of the fish, near the fin, the spider having a tail that looks like moss.

32. Whales live on them and sharks and bluefish devour them.

33. Never have known anything like disease appear among them.

34. They are caught with seines and nets.

35. The seines are 150 fathoms long and 20 fathoms deep. Nets 20 fathoms long and 4 deep.

36. The vessels used in taking them are sail-vessels of 50 tons burden, and small steamboats of 100 tons.

37. Ten men are wanted for one vessel, and one seine.

38. They fish all day.

39. They are taken equally well on flood or ebb tide.

40. The wind has no perceivable effect upon them.

41. There are, in this district, about 25 vessels, with 5 men to each.

42. The fish are caught here for oil and mackerel bait.

43. There are two small oil-factories here, one owned by J. C. Condon (of whom I get this information) and one by J. C. Mayo.

44. Condon makes 50 barrels and Mayo 25 per year.

45 and 46. Their factories could produce much more.

47. Sixty cents per barrel of 200 pounds of fish.

48. One barrel fish will make (ordinarily) three gallons of oil.

49. One ton of scrap will make 30 gallons oil.

50. The first fish that come in the spring will produce but one gallon oil to a barrel of fish.

51. In October a barrel of fish will produce from 4 to 5 gallons oil.

52. The northern fish yield four times as much oil as southern.

53. About twenty years ago, a woman living at Buck's Harbor, in Brooksville, was frying some of the fish to eat, and observing how very full of oil they were, suggested to her husband that it would pay to try them out for the oil, and he having an eye to interest, tried the experiment, by using their washboiler to try them and their tub for a press. In this way they made one barrel of oil, carried it to Boston and sold it to a Mr. Eben Philips, an old oil-dealer, who at once saw money in the enterprise, and so furnished these people with nets, kettles, and a press for their next year's business, the product of which was eight barrels of oil. After that, others seeing their prosperity, went into the business, which from that has grown to its present amount.

54. The oil is marketed mostly in Boston.

55. The scrap is mostly sold here to farmers for dressing their land.
56. The oil is mostly used for currier purposes in dressing leather.
57. The oil has sold at prices varying from 40 to 50 cents per gallon.
58. We presume it does somewhat.

3. *Statement of R. A. Friend, Brooklin, Me.*

1. Pogy.
2. Greatly in excess.
3. Apparently as plenty as in past years.
4. About 14,000 in 1873; 23,000 in 1874.
5. It does not.
6. Main body arrives from first to middle of June; usually three runs.
7. High; ripple on water; attract birds.
8. By south channel.
9. Regular and certain.
10. It does not.
11. They go with the tide.
12. In large bays.
13. No special depth; unknown.
14. It does.
16. Never.
17. From the middle of September to the middle of October; by degrees.
18. Following the coast.
19. South.
20. I should think vegetable nature.
21. Mostly south of Cape Cod.
31. Frequently have jiggers attached.
32. To a great extent.
33. Not here.
34. Seines and mash-nets.
35. Seines 8,000 meshes long, 650 deep; gill-nets 3 to 5 fathoms deep, 20 fathoms long.
36. Small schooners and steamers, with luggers; from 5 to 100 tons.
37. Seine, 12 men; gill-nets, 3 to 5.
38. Seines, all times of day; nets, morning and evening.
39. Most on ebb-tide.
40. It seems to.
41. Five; fifty-five.
42. Manufactured for oil and scrap; sent away to factories.
43. Robert A. Friend, P. Kane, Harriman Point Company, Job T. Wilson & Co.
44. Averaged 14,000 gallons the past two years.

45. R. A. Friend 50,000 gallons; Job T. Wilson 50,000 gallons; P. Kane 15,000 gallons; Harriman Point Company 20,000 gallons.

46. Job T. Wilson, steam; R. A. French, steam and pot works; others, pot-works.

47. Sixty-five cents (1873).

50. Two quarts; in June.

51. Four gallons; last of August.

53. First made by William Romer; oil taken from pots where fish were cooked for fowls.

54. Boston.

55. Boston, Philadelphia, and Baltimore.

56. Painting and currying.

57. Forty-five cents; from 30 cents to \$1.27.

58. It is not.

4. *Statement of John Grant, Matinicus Light Station, Matinicus Rock, Maine, March 31, 1874.*

1. Menhaden or pogey.

2. More abundant than any fish except herring.

3. Diminished.

4. No regular establishment or factory is run in this vicinity.

5. I think it does.

6. About the 1st of June. The larger body come about the middle or last of June. The last schools are the largest and fattest. There are commonly several schools at irregular intervals.

7. They swim high, making a ripple, and frequently showing their fins and attracting sea-gulls and other birds in great numbers.

8. They come from the south, and when driven into bays and rivers by large fish they inhabit one locality for several weeks at a time.

9. Regular.

10. Yes.

12. Between Seguin and Matinicus Rock and the bays and mouths of rivers between these points.

13. Usually on or near the surface of the water, but sometimes at the depth of 20 or 30 fathoms.

15. Yes.

16. No very young ones.

17. About the middle of October, in a body.

18. By the same, as they came rather working westward.

19. South of Cape Hatteras, near the Gulf Stream.

20. Some floating substance on or near the surface of the water.

21. Probably near the edge of the stream, south of Hatteras, during the winter season.

28. I have found them in Hampton Roads in early spring, when they were not more than two inches.

29. No.

31. No.

32. Considerably. The whale, I think, is their greatest enemy. Rising beneath the schools, as they play upon the water, with extended jaws, he forces himself up through them with such speed as to project his body half out of water, closing his jaws over large quantities of fish as he falls heavily back.

33. No.

34. Seines from 150 to 300 fathoms in length and 20 fathoms in depth, and nets about 30 fathoms in length and from 2 to 3 fathoms in depth.

35. Answered above.

36. Small schooners. Recently fifteen to twenty small steamers have been employed, the tonnage of which amounts to 1,500 tons.

37. About 500 men.

38. The fish are taken by some fishermen with set nets whenever they come to the surface.

39. No.

40. They "school" or come to the surface best in moderate winds and calms.

41. No vessels are fitted out for this business in this immediate vicinity, but large quantities of fish are taken between this station and Monhegan by vessels from other parts of the coast.

48. About 250.

50. One and a half gallons, when the first fish appear on the coast.

51. Three gallons. About the 1st of October.

52. Yes.

53. Can give no definite history.

54. Boston and Portland.

56. Painting and tanning.

58. Undoubtedly.

5. *Statement of Benjamin F. Brightman, Walldoborough, Me., March 18, 1874.*

1. Pogy.

2. The most abundant, to all appearances, as we see these and do not see the other kinds.

3. About the same, I think.

4. There were taken in the mine about 350,000 barrels by all the factories, viz: Bristol, Bremen, Joseph Church & Co., Round Pond, Loud's Island, L. Brightman & Sons, Judson Tarr & Co., Union, Wells Deblois & Brown, Kenniston, Cobb & Co., Gallup & Manchester, Gallup & Holmes, J. G. Nickerson, L. Maddocks, factories the present year, and about the same in previous years.

5. See no difference.

6. About the 1st of June the first fish make their appearance, usually scattering; commence taking in seines about the 15th. They are poor

then, and rather smaller than the fish caught in August and September, when we go off shore from 5 to 30 miles and get larger and fatter fish. We commence about the 15th of June, and fish until the 15th of October.

7. High and low both. When they are up and we can see them we get them, and when down we cannot fish, so that some days there will be good fishing and others none at all. On the seine-ground, cannot tell how deep they swim when they are down. We usually catch them here by seeing them play. Sometimes they ripple the water.

8. From southeast to the southwest, and generally lay along the coast; they are seen from Cape Sable to Cape Ann, off and on shore around Cape Cod, in the season of them—that is, an outside fish and an inside fish. Fish in the bays and rivers are called inside, and on the ocean called outside. In Maine, the fishing is done outside nearly altogether.

9. About the same for the last ten years. The fish go where the feed is.

10. See no difference.

11. Has no effect here.

12. Usually deep water.

13. We fish in deep and shoal water. Do not know how deep they swim.

14. In a sunshiny day we see them most.

15. Never saw any fish here that looked as though they came here to breed; there is some difference in the size, but could not define their age. The smaller fish go into the rivers.

16. Never saw a young fish north of Cape Cod, or old fish that looked like spawning.

17. The fish start to go west from here about the middle of September, and go by degrees up to the last of October.

18. They seem to run along the coast southwesterly.

20. It is a substance in the water which is sometimes seen; I never examined it particularly. Something like a seed or a very small lobster, or rather has this appearance; it is about one-fourth of an inch long; do not see as much of that here as in Narragansett Bay.

21. From the south side of Cape Cod to the Albemarle Sound, in all the inland waters and rivers, mostly in the southern waters, commencing south about the 1st of March and in Narragansett Bay in May.

22. Think the spawning fish leave the main body and scatter about in pairs or small schools and in shoal water.

23. Never saw the operation, but have noticed in the smoother waters in the night that the fish came close in to the shore in shoal water, and the supposition was that they were spawning. I have seen a hauling-seine haul on shore the spawns all ready to hatch.

24. The water is rather cold in the spawning season.

25. Any depth, but usually in shoal water, on the bottom.
26. Lay on the bottom.
27. In about six weeks after being laid.
28. They are in great abundance; saw more young fish in Narragansett Bay last season than ever before, but their usual spawning-grounds are south as far as Cape Lookout, mostly about the Potomac and Delaware Bay and joining shores.
29. Never saw the spawn running from the fish. We never catch them with the purse-seine for the reason that they leave the body of fish and scatter about. The spawning fish are among the first to arrive.
30. Do not know as I ever saw menhaden spawn in any other fish. The parent fish do not devour them.
31. Have seen a small crab in the fish, just under the scales, with an appendage about an inch long; never saw anything in or around the mouth.
32. They suffer to a great extent from bluefish, horse-mackerel, porpoise, sharks, whales, dog-fish, &c.
33. Never saw any diseases about them.
34. There are a great many caught in gill-nets in the first part of the season, but not so many here as formerly. The nets are made of fine cotton twine, about 4 inches mesh, and all set or anchored; the fish run into them and put their heads through the mesh. They are about 20 fathoms long and 12 feet deep.
35. The purse-seines here are made from 200 to 225 fathoms long and 100 feet deep in the middle and 70 at the ends made of fine cotton twine.
36. A small schooner of about 30 tons, with two or three open boats carrying about 200 barrels each, two men in each boat. The crew live on board the tender and lay on the fishing-grounds and the boats carry the fish to the works. The most of the fish here are caught in steamers of about 60 tons, from 30 to 50 horse-power. The steamers work better than sail gangs, on account of running in calm weather; there are 17 in the eastern fleet; they carry from 500 to 1,200 barrels each.
37. From 10 to 12 men to each gang.
38. Usually in the morning, from daylight to ten o'clock, or just at night. In calm weather all day.
39. Rather better on the rising tide.
40. We cannot keep run of the fish as well when the wind blows.
41. Fifty-four gangs, of from 10 to 12 men each. This comprises the section between the Kennebec and Penobscot Rivers. There is nothing done in Maine outside of this section except one or two gangs in Blue Hill Bay, and the next fishing-grounds are at Narragansett Bay, west, and around Long Island.
42. Carried to the factories in this vicinity.
43. The most are stock companies, but some are owned by individuals. This question is answered in question 4.

44. From 25,000 to 225,000 gallons, according to capacity. There is a great difference in the capacity; three factories here made one-quarter of the oil and one-sixth of the scrap made in the whole country.

45. From 40,000 to 500,000 gallons, if they could get fish and they were fat enough.

46. The cost of factories, including machinery, varies from \$10,000 to \$70,000, not including fish-gear and gangs.

47. Sixty-five cents were paid the last two years, but they have been as high as \$1 when oil was higher.

48. Our eastern fish average about $2\frac{1}{2}$ gallons to the barrel.

49. From 30 to 40 barrels.

50. Our first fish make about three quarts to the barrel; only a few of these caught.

51. Four gallons in August and September, when we go to sea after the fish.

52. The average is greater north, although the fattest fish caught last year, Southold Bay, Long Island, 7 gallons to the barrel.

53. The factories in Maine were built ten years ago. Since then there have been some twenty built; there are fourteen in operation now, or will be in the season of fishing.

54. Boston and New York.

55. The manufacturers of superphosphate use principal part of it, although the farmers use it as it comes from the factory; it is too strong of ammonia to use raw, varying from 7 to 12 per cent.

56. Mostly used for tanners' oil.

57. Forty to sixty cents per gallon. Have known it to be sold for \$1.35 per gallon.

58. Do not see any variation for the last ten years.

6. *Statement of L. Maddocks, Booth Bay, Me., December 25, 1877.*

The names and tonnage of my steamers are as follows: Steamer Mabel Bird, 80 tons; steamer M. M. Fish, 80 tons; steamer Grace Darling, 75 tons; steamer Phebe, 70 tons; steamer S. L. Goodale, 70 tons; steamer H. M. Price, 20 tons.

7. *Statement of G. B. Kenniston, Booth Bay, Me., February 14, 1874.*

1. Known about equally as poggy and menhaden.

2. It is found in numbers almost incomparably greater than any other.

3. Increased.

4. In this town (Booth Bay), in 1873, were taken 152,000 barrels, as follows: Kenniston, Cobb & Co., 17,000; Gallup and Holmes, 17,000;

Gallup and Manchester, 25,000; Suffolk Oil Works, 48,000; Atlantic Oil Works, 45,000. In 1872 the aggregate reached about 110,000 barrels. In 1871, with six factories instead of five, were taken about 95,000 barrels. In 1870 less than 75,000 barrels were taken, while in 1866, the first year of work here, not more than 35,000 barrels were taken. The great difference in these results may be ascribed to three causes: (1.) The fishermen have acquired skill in the business. (2.) Much better apparatus for the capture of these fish is now in use. (3.) The fish are more abundant than formerly.

5. Not perceptibly.

6. First seen about May 20 in occasional schools. Main body arrives about June 20, which, passing eastward, is followed by others continually for about thirty days longer. There is considerable difference in the size of fish caught. At times, mixed sizes are taken at the same set; usually, these arriving at different periods of time, differ in size. Larger may come sooner or later. Nothing certain is known as regards this.

7. Probably near the surface. Their arrival is known only by their "play," *i. e.*, flipping, or striking the water with their tails.

8. After rounding Cape Cod, some touch the coast in the vicinity of Gloucester, Mass., but the larger portion, by far, it appears, keep off shore, and near it anywhere from Cape Elizabeth to Monbegan. The main body of these fish continue to pass toward the east till about the 20th of July, when that impetus seems to be checked, and for thirty or forty days their movements are seemingly local. Then they begin their return to the west, and continue to repass, until in October the last bodies are urgent in the westward course.

9. Very regular. Never fail to come.

10. Yes. They are farther off shore, but not, it is believed, from their feeding-ground.

11. No relation discoverable.

12. In this vicinity, from five to thirty miles from land.

13. Depth not material.

14. No. Temperature of air does. They will not "show" or come to the surface when cold north or east winds prevail.

15. No.

16. No.

17. In September and October, as described in No. 8.

18. By the same as that by which they arrive; described in No. 8.

19. About the Bahama Banks and Florida Keys.

20. Animalculæ.

21. Where they pass the winter (No. 19) in January and February.

22. The writer has reason to believe them to be indiscriminately mixed.

23. Yes.

24. Am unable to give the temperature of Bahama waters.

28. Yes. About the sounds of Carolina and Chesapeake Bay.
29. Never in Maine. It will appear in late southern fishing, November and December.
30. Am unable to say. Parent fish does not devour them.
31. Worms occasionally found in the head.
32. Immensely.
33. Never.
34. Seines.
35. Length, 500 yards; depth, 60 yards.
36. Steamers, schooners, and sloops varying from 20 to 70 tons, new measurement.
37. Ten usually make a crew.
38. While they can see. From daylight till dark.
39. No.
40. Prevents their capture by "raising a sea." Cold winds cause them not to "show."
41. In Booth Bay, 21 crews, 210 men.
42. Sent at once to the works to which the catching crew belong. Each gang fishes for the factory which provides the apparatus for fishing.
43. They number six: A. Suffolk Oil & Guano Works, J. G. Nickerson. B. Atlantic Oil & Guano Works, Luther Maddocks. C. Works of Gallup & Holmes. D. Works of Gallup & Manchester. E. Works of Kenniston, Cobb & Co. F. White Wine Brook Company's Works, G. B. Kenniston and others.
44. Depends wholly on the number of barrels of fish secured and their fatness, both of which vary each year. For 1873 the following is about the result, using letters as above to designate the figures: A. 120,000 gallons. B. 112,000 gallons. C. 42,500 gallons. D. 62,500 gallons. E. 42,500 gallons. F. Not run.
45. Fifty per cent. in addition to the amount usually made.
46. Factories vary in cost from \$10,000 to \$60,000.
47. In 1873, 75 cents per barrel. In previous years, from 50 cents to \$1.25 per barrel.
48. Barrel averages $2\frac{1}{2}$ gallons usually.
49. Varies with the time of the season, whether it be in June or October.
50. Three pints. May.
51. Six and one-half gallons in October.
52. Yes, average; though Southern fish late (December) are very fat.
53. Began in Maine in 1865. Grew rapidly for four years. Not augmented any since 1870, except in method and means of taking the fish.
54. Boston, New York, and export.
55. Massachusetts and the Southern States.
56. Sold largely for curriers' use, and to adulterate higher-priced oils.
57. From 35 to 48 cents. Previous years, from 33 cents to \$1.05.

58. Not sensibly.

The inception and growth of this business in the adjoining town of Bristol is contemporaneous with Booth Bay. In 1873, the works of that town probably pressed 250,000 barrels of fish, yielding 625,000 gallons. of oil. There are about eight works.

8. *Statement of Judson Tarr & Co., Rockport, Mass., and Booth Bay, Me., January 23, 1874.*

1. Menhaden.

2. Are most numerous of any fish on our coast.

3. Have increased in the last ten years.

4. Number of barrels caught in Maine during 1873 was about 400,000, of which we caught 60,000.

5. The extensive capture does not lessen their abundance. Should say they have increased within five years, but not so abundant inshore.

6. Menhaden are first heard from in March as far south as Cape Henry. They come on the coast of Maine about June 1, but the main body does not get along until June 20; they are then constantly coming along until July.

7. They come in schools and make a ripple on the surface of the water.

8. They usually follow the shore in coming and going.

9. They never fail.

16. Never see any small fish on the coast of Maine.

17. They leave our coast about October 1. Cold weather drives them south.

19. Think they go as far south as Florida.

20. A sort of red seed, floating on the surface.

21. They spawn South.

30. The larger fish, such as the whale and shark, are their greatest enemy. The blue-fish destroy great quantities.

34. They are caught with seines.

35. One thousand to 1,500 feet long and 100 feet deep. They are called purse-seines, and cost \$1,000 each.

36. Vessels and steamers of from 40 to 100 tons are used in catching them.

41. Whole number of vessels, 33; 17 of which are steamers. There are about 500 fishermen.

44. Number of gallons of oil produced by all, 1,000,000; tons of scrap, 12,000.

50. Yield less than one gallon to the barrel.

51. They yield most oil in September.

56. It is used principally for currying purposes.

57. Average price of oil, 45 cents per gallon; scrap, \$15 per ton.

The phosphate that is made from the scrap is used mostly in the South.

ern States for raising cotton. Considerable is also used for raising tobacco. Used to a certain extent in every State in the Union. This business is prosecuted quite extensively in Narragansett Bay and Long Island Sound, Rhode Island, Connecticut, and New Jersey. Commences one month earlier, and lasts one to two months later in season. The whole number of factories in that vicinity is about 50, but many of them are small. The amount of capital invested is \$1,500,000. The number of barrels of fish caught is 793,100; amount of oil, 1,200,000 gallons; amount of scrap, 24,000 tons.

Size of our factory: Main building, 130 by 40 feet, 16 feet post, having two stories. The upper one is used for cooking and pressing fish; the lower story for oil-room and fish-scrap. The engine-house adjoining the factory is 20 by 30, 10 feet post, containing three horizontal boilers, 65 horse-power each. In the upper part of factory there are eleven cooking-tanks made of wood, round, 12 feet in diameter and 4 feet deep, with steam-pipes in the bottom, having several small holes in them to let steam into these tanks. There are also three hydraulic presses, 150 tons pressure each, and one engine of 10 horse-power. In connection with factory are two wharves, one 150 by 50, and one 40 by 80. On the largest wharf is a tank set up on posts 10 feet high. This tank has a capacity of 4,000 barrels, which we sometimes have full at night after discharging all of our steamers with their day's catch. We have a 12-horse engine on the wharf used for hoisting fish out of steamers; have three drums connected with engine so as to run all at one time or either one we wish. We can unload one thousand barrels an hour when in full blast. The fish are discharged same as coal is unloaded, and are dumped into tanks on the wharf. In connection with the factory is another building for the main scrap-house, 60 by 100, 15 feet post; also blacksmith-shop, cooper-shop, carpenter-shop, boarding-house, stable, &c., all on the premises and used in connection with the business. These cost from \$75,000 to \$80,000, and the steamers and fishing-gear, such as seines, small-boats, &c., not less than \$60,000 more. There are but two pogy factories in the United States of this capacity, and are both in the town of Bristol, respectively owned by Joseph Church & Co., Tiverton, R. I., and L. Brightman Sons, Round Pond, Me., or Fall River, Mass. Next largest are those of L. Maddocks and J. G. Nickerson, in Booth Bay, adjoining town, about half as extensive as the above. The others are smaller. Perhaps they may average one-fourth capacity of first three.

General process of manufacturing.—First, the fish are landed on the wharf or in tanks; then they are conveyed to the upper story of the factory in cars holding about 20 barrels, on wooden rails set upon wooden horses; then they are emptied into the cooking-tanks. Put in first 6 inches of salt water, then 50 to 75 barrels of fish, in each tank, and open steam from main pipe and boil them one hour. In that way two-thirds of the oil comes out of the fish. We then draw this oil and water off below into drawing-off tanks for this purpose, and run it

through from one to another until it is run through several, keeping it hot all the while. After doing this the oil comes to the surface and the water separates and goes to the bottom. Then the oil is run off into a tank holding 4,000 or 5,000 gallons, called a settling-tank. After remaining there a few hours it is pumped up and run off into bleaching or drawing-off tanks, of which we have five, holding 4,000 gallons each. There it remains one to two weeks. Then it is put into kerosene-oil barrels and shipped to New Bedford, New York, and Boston, and sold to dealers in fish oil. In regard to pressing: After the fish are cooked or steamed and drained, then they are put into round curbs holding 10 barrels each, made of iron one-half an inch thick, perforated with holes one-eighth of an inch in diameter. These curbs are then put under a steam hydraulic press of 150 tons pressure, when the water and oil all come out together and are separated as before. Our capacity is 2,000 barrels per day, but we do not always get that amount; sometimes more and sometimes less. Oftentimes we do not have any fish for a week. We average about four fish days in a week. They are employed in Maine about sixteen weeks. First oil extracted from menhaden is said to have been done by a woman in Frenchman's Bay, near Mount Desert, Me. It was manufactured in the house on the cook-stove or fire-place, tried out in a common wash-boiler. This oil was put up in bottles and forwarded to E. B. Phillips, of Boston, and he gave the manufacturer encouragement and furnished nets and try-kettles, set up outdoors in brick, holding, say, 50 gallons. The fish were boiled and the oil skimmed off the top, and the balance was thrown away. In this way they could not get over two-thirds of the oil, and it was thought best to press the refuse, but no one knew how to do it. The first process of pressing was in tubs and barrels by making holes in them and putting rocks on top. The scrap was thrown away. This was twenty-five to thirty years ago. I do not think the porgie business will be increased any at present, as there could be an overproduction of oil. The fish are not likely to diminish. We employ at the factory about thirty-five men.

9. *Statement of Mrs. B. Humphrey, keeper of Monhegan Island Light, Monhegan Island, Me., February 4, 1874.*

1. Pogy.
2. They are more numerous than other kinds of fish.
3. Diminished.
5. It does.
6. The first of June. The first are the smallest.
7. The fish swim high and make a ripple on the water.
8. They follow the shore along from the southwest to the northeast.
9. The appearance of the fish on the coast is regular.
10. It does.
11. The fish play with the tide.

12. Harbors and bays.
13. They swim near the surface.
14. It does.
16. They are seen at half size.
17. They leave the coast in October and November.
18. They leave the coast by the same route that they came.
19. They winter at the South.
20. They eat the grasses and seeds on the water.
21. The fish spawn at the South.
27. They spawn south of Cape Hatteras.
28. During the winter months.
31. There is nothing attached to the mouth of the pogy.
- 34 and 35. Seines measuring 200 fathoms in length.
36. Steamers and sail-vessels.
37. Requires ten men to manage one vessel and seine.
38. From sunrise to sunset.
40. The wind does affect them.
41. There were no less than 111 vessels, of which 17 were steamers.
42. They are made into oil and guano at different places.
43. The nearest oil-factories are situated in Bristol, 15 miles from this place.
47. Price paid per barrel for fish is 75 cents.
48. Sixty-five fish will produce one gallon of oil.
52. The northern (Maine) fish produce more oil than southern fish (Long Island).
54. New York and Boston.
56. It is used principally for paint.
58. It does tend to diminish the fish.

10. *Statement of J. Washburne, jr., Portland, Me., February, 1874.*

1. Pogy.
2. Is of greater abundance than any other, except the "mackerel," and possibly the "herring" fish.
3. Has increased.
4. 440,000 barrels taken by all establishments in this State in 1873; in 1874, 632,261 barrels.
5. The extensive capture here does not appear to affect the abundance.
6. The first come about June 15; there are two schools; the first, which are small, usually come about ten days before the second school.
7. The first swim high; their arrival is first known by capture; they make a ripple and attract birds.
8. Come from the south, move north, and again to the south.

9. The appearance is quite regular, and they do not come in greater abundance one year more than another.

10. The use of nets, seines, &c., does not appear to scare them from their usual feeding grounds.

11. Does not appear to affect their movements.

12. On the coast of Maine, between Cape Elizabeth and Matinicus Islands.

13. Twenty fathoms.

15. Do not come on to breeding-grounds before maturity. Two-year-old fish are the oldest.

16. Never seen.

17. About October 1, in a body.

18. Southerly.

19. South of Cape Hatteras.

20. A seed.

21. During the winter in southern waters.

26. Spawn are never seen in these waters.

27. Eggs are never seen in this vicinity.

28. None are ever seen in these waters.

29. No.

30. Whales, sharks, blue-fish, seals, &c.; don't know that the parent fish destroy their young.

31. No.

32. Greatly.

33. Never hereabouts.

34. Pass seines.

35. Two hundred to 275 fathoms long.

36. Both steam and sailing vessels, from 40 to 150 tons chiefly; some small boats.

37. About ten men for the usual class employed.

38. Ten hours.

39. No.

40. The catch is better with a southerly wind.

41. One hundred and ten vessels, carrying an aggregate of five hundred men.

42. The fish, as soon as caught, are sent to the oil factories on shore.

43. There are thirteen oil factories on this coast owned by various individuals.

44. The quantity produced in 1873 was 1,000,000 gallons.

45. Thirteen factories, employing 446 men, caught 440,000 barrels of fish, yielding 1,000,000 gallons of oil, 13,000 tons of guano, and 2,337 barrels of bait, valued at \$352,550.

46 and 47. About one dollar per barrel. During the war, prices were much higher.

52. Yes; one-third more.

54. Boston and New York.

55. Boston.

56. Used for painting and for currying leather.

57. Forty and fifty cents per gallon in 1873.

58. Does not appear to.

11. *Statement of Chandler Martin, keeper of Whales-Back Light, Whales Back, N. H.—February 23, 1874, and January 9, 1875.*

1. Pogy.

2. Most numerous, excepting herring.

3. More abundant in 1874 than for ten years previous.

5. Does not on this coast.

6. From the first of May until the middle of July. The first are generally the smallest.

7. High; they make a ripple and attract birds.

8. Along the shore from the coast of Massachusetts to the coast of Maine.

9. Regular, but more numerous some seasons than others.

10. Nets and seines keep them out of the harbors.

11. Go with the tide.

12. Bays and harbors with strong tides.

13. Shallow. From 4 to 10 fathoms.

14. It does.

15. They are full grown when they visit this coast.

16. They are not.

17. They leave in a body from the first to the middle of October.

18. As they came, along the shore.

29. No.

34. Gill-nets and seines.

35. Gill or float nets are six yards deep and forty yards long. Seines are of different lengths.

12. *Statement of Thomas Day, keeper of Sequim Light, Parker's Head, Me.*

1. Pogy.

3. In my opinion they are diminishing.

6. The first school gets on the coast of Maine about the middle of May; the second about the middle of June.

8. These first go and come the same way as the mackerel.

10. Yes, seines tend to drive them from off the coast. There is a fine of \$50 for throwing a seine within three miles of the shore; but this is willingly paid when they can take 1,000 barrels of fish in a few hours.

34. Gill-nets and seines and in weirs.

35. Seines are 1,500 feet long and 80 feet deep.

36. There are at present about 75 small steamers besides many sailing-vessels.

37. Each steamer and sailing-vessel will average eight men each.
 42. Boiled for oil; the chum is sold for manure.
 47. The poggy is worth, on an average, \$1.25 per barrel.
 57. Oil is worth about 50 cents per gallon.
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13. *Statement of William S. Sartell, Pemaquid Light-Station, Bristol, Me.—February 1, 1874.*

1. Menhaden or poggy.
 3. Diminished.
 5. Yes.
 6. May 20.
 7. They swim near the top.
 8. From the South.
 10. It does, for they were not seen from this station last summer.
 17. September. It is done in a body.
 18. They go South.
 20. It is a small red seed that floats in the water.
 21. South of this place.
 34. Seines.
 35. Twelve hundred feet long by 360 feet deep.
 36. Steamers and schooners.
 37. Ten men.
 38. All day.
 40. It does.
 41. Sixteen steamers and 30 schooners and sloops.
 42. Fried out for the oil.
 43. Seven factories. In 1873, J. Tar, Bingham & Co., L. Nickols & Co., Union Factory, and three others.
 44. In 1873, J. Tarr used 85,000 barrels fish, Bingham & Co. 1,000,000 barrels, L. Nichols & Co. 50,000 barrels, Union Factory 25,000 barrels, and three others 25,000 barrels each.
 47. Sixty cents (1874).
 48. From three gallons to one barrel.
 52. Yes, in the summer.
 54. New York and Boston.
 55. All over the country.
 57. Forty-five cents (1874).
 58. Yes.
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14. *Statement of Alden H. Jordan, keeper of Baker's Island Light, Cranberry Isles, Me., December 29, 1873, and February 9, 1874.*

1. Poggy.
2. About 100 per cent. more.
3. Diminished.

4. There was none of any account; in 1861 there was quite a catch in this vicinity, mostly in small boats; since that time the fish have diminished to a great extent.

5. It does.

6. About the 15th of June, and then, about six or eight days after, the main body arrives, the first fish that come being as large as any. They come in schools, one after the other.

7. Swim high in moderate and calm weather; they make a ripple and attract birds.

8. From the west, following the coast.

9. Regular.

10. Yes.

11. They play in on the flood and out on the ebb.

12. They play in the tide about one-half mile from the shore.

13. About 18 fathoms. From 2 to 4 fathoms.

14. It does not.

15. The ground in this vicinity appears to be their feeding-ground. They are all of one size.

16. Not any.

17. About the 20th of September.

18. West.

19. South.

20. Shrimp.

29. No.

31. Never saw any.

32. To a great extent.

33. Not any.

34. Nets are knit of twine; $3\frac{1}{2}$ -inch mesh.

35. Length, 25 fathoms; depth, 2 fathoms.

36. Steamers and schooners, from 20 to 30 tons.

37. Four to twenty.

38. Two-thirds.

39. Yes; on the flood.

40. Yes; it makes them swim deep.

41. None.

42. On the spot, or sent to Brooklin, Me.

43. None.

47. Those that catch the fish keep them for bait, or for their oil, in this vicinity.

48. About 55.

49. About all the scrap in this vicinity is put on the ground for dressing.

50. About 3 gallons when the fish are first caught.

51. About $5\frac{1}{2}$ gallons in September.

52. Yes. I think the first fish were caught in 1858.

54. Boston, Mass.

55. Boston, Mass.

56. It has been used for paint for the past thirteen years.

57. Price per gallon, 45 cents. In 1861 it averaged \$1.38 per gallon.

58. It does to a great extent.

15. *Statement of Washington Olin, keeper of Pond Island Light, near Boothbay, Me., February 18, 1874.*

1. Menhaden or poggy.
2. More abundant than any other fish.
3. Diminished.
5. It does.
6. In May; the main body arrives in July. The July fish are the largest.
7. They swim at the top of the water and make ripples.
8. They come from the south.
10. Tends to scare them.
12. Very near the sea-shore.
13. Generally at the surface.
16. They are not.
17. They leave the coast in the fall.
18. Go south.
31. Worms are sometimes found in them.
33. No disease of any kind.
34. Purse-nets or seines.
35. Length from 200 to 225 fathoms; depth from 15 to 25 fathoms.
36. Steamers, from 75 to 100 tons.
37. From 10 to 15 men.
38. All day, if the weather is fine.
42. Steamed and pressed for oil at Boothbay.
43. Not any nearer than Boothbay; owned by Luther Maddocks.
47. From 40 cents to \$1.25 per barrel.
48. Four hundred in May; 100 in August or September.
50. One gallon in May.
51. Four gallons in August or September.
54. Boston and New York.
55. The Southern States.
56. For painting.
57. About 50 cents.
58. Very much, and drives them from the land.

16. *Statement of an unknown correspondent, Gloucester, Mass., March 28, 1874.*

1. Menhaden, hardhead, or poggy.
2. About the largest (if not the largest) school of fish that visits our coast.

3. Have not seen much of them for the past eight years, but should think that they had diminished a small per cent. during that time.

4. There are no establishments here engaged in the manufacture of menhaden oil.

5. Do not think it does.

6. About the 15th of May, and are the most plentiful about the 1st of June. The first are generally the largest. Generally two, about one week apart.

7. Sometimes at the surface, and oftentimes they pass along without any show. I should think, from an experience of twenty-five years, that they never go below 5 fathoms from the surface of the water. Their general habit when on or near the surface is to slap—that is, to raise the tail and strike it down on the water. This produces a sound different from any other kind of fish. They, as a general thing, make a small ripple on the water, and oftentimes they can be told by the color of the water which covers them. It presents a yellowish color, as a general thing. Do not attract birds.

8. They come from the south, and, as a general thing, follow along the coast, sometimes near the land, but of late at the distance of from three to twenty miles from land, along the coast of Massachusetts to the coast of Maine. I never heard tell but once of their crossing the Bay of Fundy.

9. Regular and certain; they do not.

10. I think it has a tendency to do so.

11. As a rule, more apt to come to the surface in deep water; in shallow water they go in and out with the ebb and flow of the tide.

13. If not disturbed they would stay near to the shore, but about 5 fathoms when out of sight.

14. It does. Cold easterly winds tend to keep them beneath the surface; warm southwest winds and clear sky appear to put them in a playful mood.

15. Could not say, but should not think they came until the second year; should think not.

16. Never saw any but once in the month of August; about 3 inches in length.

17. In the month of November, by degrees; that is, they pass along day by day until all are gone.

18. They go southward.

19. Could not say, but have heard of them in the month of February on the coast of Florida.

20. Suction, or on the small particles to be found in the water.

21. Never knew, but think where they spend the winter.

23. Never knew it to be.

25. Should think on the bottom.

26. Do not know, but think they remain at the bottom.

28. Not around this coast.

29. Not around these parts.
 30. Cod, pollock, and various other kinds; the parent fish does not.
 31. Never saw any such.
 32. The bluefish is the only deadly enemy.
 33. About eighteen years ago they died in large quantities, and were piled along the coast of Maine for miles.
 34. Seines and gill-nets.
 35. Seines are from 150 to 240 fathoms long and from 10 to 30 fathoms deep. The nets are about 20 fathoms long and 5 fathoms deep.
 36. Fore and aft vessels, from 30 to 80 tons.
 37. From 5 to 12 to each vessel.
 38. Depends on the weather and the fish.
 39. Generally more taken on the flood than on the ebb tide.
 40. Easterly winds do.
 41. About 45 sail for 1873, and about 500 men.
 42. In Gloucester, the greatest fishing port of Massachusetts, they are used for bait; but some are carried in ice to George's Bank, and the remainder are slivered; that is, the sides are taken off and head and backbone thrown away, and salted for the mackerel and Grand Bank fishing.
 43. None.
 47. From \$1 to \$2.50 for fresh, and from \$6 to \$9 for slivers, per barrel.
 48. Spring of the year about 2 quarts to 1 barrel; when in good order, last of August, 3 gallons to 100 fish.
 50. See question 50.
 51. See question 50.
 52. Think they do, as a general thing.
 54. Boston, Salem, Danvers, and other places.
 55. Sold from factories and carried to different places in Maine and Massachusetts.
 56. Sometimes used for leather, but more often to mix with linseed-oil to cheat the consumer.
 57. About 40 cents per gallon.
 58. In pressing out the oil some gets overboard and makes a calm streak on the water; this the menhaden will not cross, so that I think this, if it does not diminish, at least drives them farther from shore.
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17. *Statement of Capt. F. J. Babson, Collector of Customs, Gloucester, Mass.*

1. The name usually employed by fishermen to designate these fish in the waters of Massachusetts and Maine are hardheads, pogies, menhaden.

2. They are found in great abundance in this vicinity, and apparently exceed in quantity all other fish except mackerel and herring, between which the disparity is not noticeable.

3. They have doubtless decreased within the last ten years.

4. During the past year about 60,000 barrels of round fish were caught by vessels from this district, all of which were used for bait for mackerel and codfish. The side of the fish is cut longitudinally from the head downward, on either side of the bone, while the head and vertebræ are thrown away; the pieces cut off, called slivers, are salted and packed in barrels for bait. Three barrels of round fish will make one barrel of slivers. Nearly all the pogies caught in this district are used in this manner for bait. There are about 800,000 barrels caught off the coast of Maine, all of which are used in making oil. The refuse, or chum, being used for manure.

5. Their numbers doubtless decrease from their extensive capture.

6. The first appearance of these fish in Massachusetts Bay is about the 15th of May, alternating in quantity, and culminating about the 15th of June. The first arrivals are the largest. For a few days they are seen, then disappear, then reappearing in about three days in large quantities.

7. They swim near the surface, and are often seen with their heads out of water going in one direction. Their arrival is known by observation, as they always show themselves, and in moderate or calm weather they can be seen for miles schooling, or breaking water as it is called.

8. They come along the coast from the south, that is, taking Cape Cod as the southern boundary of our vessels' operations, and from thence follow the coast of Massachusetts and Maine as far north as the southern limit of the British possessions, but they are not taken on the British coast. (Under the Treaty of Washington this extensive fishery is now thrown open to British fishermen, when formerly they were obliged to buy pogy bait from our fishermen.)

9. They have not failed to make their appearance regularly for the past thirty years, and always in large quantities.

10. Since they have been taken in large quantities for their oil they have gradually avoided the bays, creeks, harbors, and rivers, where they once resorted in immense numbers, and are now principally taken from one to ten miles from the shore. Some of the fishermen maintain that since the advent of the bluefish (the most destructive fish in our waters) some twenty years ago, the pogies have sought deeper water for their own safety, while others maintain that the bluefish drive the pogies into shoal water; doubtless both statements are at times true.

11. When in deep water, subject to but little action by the tide, they are not apparently affected, but when in close proximity to the shore they will go up rivers and creeks with the tide and come out with it. They naturally tend inshore mornings and go off evenings.

12. Chesapeake Bay, Long Island Sound, and along the coast of New England, are their most favorite resorts.

13. They are found in all depths of water, and usually swim low during easterly winds.

14. In pleasant and warm weather they frequent the surface when the water is warm.

15. They do not breed upon the coast or waters of Massachusetts or Maine, and we have no evidence at what age they become mature. It is rare to see any but the full-size fish, or very nearly so. Usually the fish caught are of equal size, and apparently being of the same age.

16. Young fish have been seen, but at rare intervals, in schools by themselves, in size about half grown.

17. They leave our waters by degrees, beginning about the 1st of October, and by the 30th they are all gone.

18. They follow the coast apparently in the same manner as they come, to the south.

19. They are found in the winter in the vicinity of Cape Henry and Cape Charles, but doubtless they are mostly in the Gulf-stream. They have also been seen in winter on the southwest edge of George's Bank.

20. They feed while in northern waters upon a red bug, or animalculæ, that floats on the surface of the water. This they imbibe by suction, for they have no teeth.

21. The spawning-ground of these fish, so far as the observation of the fishermen extends, is in Chesapeake Bay, Long Island Sound, and the waters adjoining. No indication of their spawning exists in our waters, and in a catch of many thousands there is seldom seen a single fish with spawn in them.

22. There are no indications of the sexes observed while in our water.

26, 28. The young of these fish are seen in the vicinity mentioned as their spawning-ground.

30. Sharks, blue-dogs, porpoises, but the most destructive is the blue-fish. Have never heard of the parent fish devouring the young. Whales have been seen in active pursuit of them.

31. No animals are found attached to them while north.

32. There has been no ratio determined.

33. There has never been any sickness or epidemic while in Northern waters.

34. Seines and gill-nets are used in their capture. These fish never take the hook nor pay any attention to bait thrown as for mackerel.

35. The average seines used are 200 fathoms long, 18 fathoms deep, some longer, some shorter. The gill-nets are 25 fathoms long, 6 fathoms deep, $3\frac{3}{4}$ -inch mesh.

36. The vessels employed in this district are schooners and steamers. The schooners are wholly engaged in taking them for bait. The steamers are connected with oil-factories in Maine. Schooners are from 20 to 70 tons; steamers 65 tons.

37. About 10 men are required to each vessel.

38. The fish are taken at all times during the day.

39. As most of the fish are taken off the shore, the tide has no effect.

40. When it blows hard the seines cannot be set, as the fish do not show themselves as in moderate weather.

41. The number of vessels in this district is 40, employing 400 men. Capital, \$200,000; value of bait taken, \$80,000.

42. Those that are used as bait are slivered and salted in barrels; those taken for oil are taken ashore to the factories, where they are placed in immense tanks and subjected to the direct action of steam; they are then put into hydraulic presses, operated by steam and water.

43. There are no factories in this vicinity for making pogie-oil. Other fish-oils are extracted at two factories, owned by A. W. Dodd & Co., and George J. Tarr, both of which are at Gloucester. There are 14 pogie-oil factories in Maine; most of them are in Bristol.

44. The amount of oil manufactured each year at these factories is 1,000,000 gallons; an average of 71,000 gallons each.

45. During the fishing-season, in case they have the fish, these factories could use 100,000 barrels of fish, or at the rate of 700 or 1,000 barrels per day.

47. The companies owning the factories usually own their fishing vessels.

48. Seventy-five fish, when fat, will produce a gallon of oil, that is, in August and September. When they first come on the coast it will take 300 fish to a gallon.

49. The scrap or pumice is the refuse after the oil is extracted from the fish. This is sold for manure, at \$15 per ton.

50. About a gallon per barrel is obtained when they first come, say in May.

51. Four gallons to the barrel of fish in September is the average yield.

52. They do.

54. It is sold all over the country: at Boston, Danvers, New Bedford, and most of the large cities.

55. Scrap is used mostly in the South as a fertilizer for cotton and tobacco, and farmers everywhere use some of it.

56. It is mostly used in currying leather, some for painting and for machinery.

57. Average price, 44 cents per gallon.

58. Reports differ; some think there are as many one year as another, but that they keep off shore more; others think they diminish.

I herewith propose to add a few facts and a detailed description of the business, that may be of some value and which are not covered by the questions. The pogie business in this vicinity has ever been conducted on a small scale, as the fish have been taken entirely for bait. There was no large amount of capital invested until they were taken for their oil and manure. Vessels are fitted from this port on the same basis as the other fisheries: The owners of the vessels finding the vessel, outfits, seine, and boats; the crew going at the halves (as it is called), that is, having the proceeds of one-half of the entire catch for their services, the other half going to the vessel. A good vessel with boats

and seine costs about \$6,000; the seine alone is worth \$1,000, and will last with fair usage two years. They are made from cotton twine, and are preserved by salt and tar. The seine is carried on a small deck on the stern of the seine-boat; this boat is about 36 feet long and 8 feet wide, and is built similar to the old-style whale-boats; they are always towed astern of the schooner, and when a school is seen the boat is rowed outside of them and the seine is thrown over; one end being taken by the wherry or dory in attendance, while each describes a circle around the school of fish until the seine is all overboard and the ends of the seine are joined. As the pogies do not sink as mackerel do, they are thus inclosed in a wall of netting 18 fathoms deep, and then, by means of a small rope rove through consecutive rings on the lower edge of the seine, the bottom is drawn together like a purse, and the fish are thus confined in a basket-shaped net. The surplus folds of the net are then gathered up until the fish are left in a small space like drawing a basket gradually from the water. The vessel is then brought alongside the seine and small dip-nets are used to bail the fish from the seine to the deck of the vessel. Often such large quantities are taken in the seine that the vessel is filled and many of the fish are killed by the close confinement and weight of the others; and when the seine is opened for their release they are mostly dead. This difficulty is obviated if there are other vessels near, who usually take the surplus fish, giving the value of one-half to the successful vessel. After the fish are taken, when they are to be used for bait, they are slivered into barrels and salted; sometimes they are sold fresh; and as the vessels bound to George's Bank use ice to preserve their fish, the bait is placed on ice and thus kept fresh. But by far the principal part is salted and used by mackerel-catchers; this bait is ground into a fine consistency, and is thrown along the side of the mackerel-catcher to *toll* the mackerel to the surface and keep them alongside the vessel. There are about 60,000 barrels of pogies taken by the bait-catchers from this district, and these produce 20,000 barrels of slivers, worth to the producers \$4 per barrel. It is observable that these fish are much fatter while on the coast of Massachusetts and Maine than when on the more southern coasts.

18. *Statement of Simeon Dodge, Marblehead, Mass.*

JANUARY 9, 1875.

SIR: Your circular of December 20, with letter inclosed, is at hand. In reply thereto, I can see no reason at present to change the general conclusions in my previous communications, although, of course, the statistical portion is undergoing a constant change. I herewith present such additional facts as come within my knowledge.

1. They are known here as hardhead or menhaden.

2 and 3. Greatly diminished. Less abundant than other fish.

4. All that were taken were sold fresh for bait, and would probably not exceed 50 barrels.

5. Probably.

6. About the 9th of May; the main body or smaller-sized ones about July.

7. They swim deepest when they first arrive, although usually with their noses at the surface, so as to be plainly seen by birds, &c.

8. When first seen they move along the coast from the south toward the north; subsequently return toward the south across the bay.

9. Their appearance is regular, but the number constantly decreasing; have never known them to fail for a season.

10. Seining tends to destroy the shoals, and large numbers are killed that are not secured. And this fact *will apply to all shoal as well as other fish*, which, together with trawls, are fast destroying all our fishing business.

11. They move upward with the flow and back with the ebb tide.

12. At the mouth of fresh-water streams.

13. Shoal water, though they have been caught 4 fathoms below the surface.

14. They are usually found deeper when the water is cold, when they first appear.

15. The first shoal are, apparently, mother fish, as the shoals that follow are smaller and younger.

16. The young fish are found in inlets and coves the latter part of August.

17. They leave the coast the latter part of October in a body.

18. Across the bay to the south.

19. Unknown.

20. A reddish substance resembling ground cayenne pepper.

28. They are not. Very few are found in coves, &c.

29. No.

30. The parent fish do not destroy them.

31. Worms are sometimes found in their gills.

32. They are destroyed to some extent by sharks and blue-fish.

33. No.

34. 3½-inch mesh, formerly 4½ inch, showing that the size of the fish has diminished.

35. Seines 150 fathoms long by 12 fathoms in depth are usually the dimensions.

36. Small boats are used here generally, although larger craft from other ports fish within our waters.

37. In larger vessels 10 to 13 hands.

38. At any time during the day.

39. No.

40. No.

41. None employed.

42. Bait for codfish, and tollings for mackerel.
 - 43, 44, 45, and 46. None.
 47. \$1 per barrel for fresh; \$6 for salted.
 58. It certainly seems to, although there may be other causes unknown at present. There is one fact which cannot be denied, and that is that these fish, once so plenty, have become almost extinct in these waters.
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19. *Statement of Eben B. Phillips, Swampscott, Mass., January 21, 1874.*

1. Menhaden; sometimes as pogies.
2. It is the most abundant, except, perhaps, mackerel.
3. It has neither diminished nor increased.
4. There are no establishments in this vicinity.
5. No.
6. In April they appear on the coast of New Jersey; in May they reach Rhode Island and Connecticut; by the middle of May or 1st of June they come here, and early in June reach Maine, the body of them arriving on the coast of Maine early in July. They leave by the middle of September, or first of October, and go south, no one knows how far. The first are not larger than the others. Many schools come in at same time. They are coming for a month, and going for a month, in streams 300 or 400 miles long.
7. They swim high when they come. In the fall they swim deeper, 6 to 50 feet down. They make a ripple. They do attract birds, viz, fish-hawks—not gulls, nor any other bird.
8. They come along shore, as stated in No. 6.
9. Their appearance on the coast is regular and certain; they never fail, except that they do not come close to the shore, and up the rivers, as much as before; they lie off.
10. Yes. And they can be caught better off shore. We don't want the seine to touch bottom.
11. None.
12. In summer from Portland to Mt. Desert they frequent the mouths of rivers—not very shoal waters. They are also found in abundance on George's Bank.
13. Answered above.
14. No, except when the weather is frosty, when they leave. Sometimes, when it is warm and sunny, they come to the surface.
15. We do not find immature fish with mature ones on the breeding-ground. In this they differ widely from mackerel, of which all sizes are found together. I think they get their growth in a year.
16. We never see small fish.
17. The fish leave as above stated, and leave by degrees, moving two or three miles per hour, and at twice that rate when the wind is north-east.

18. They stick to the coast, sometimes following the bend of Cape Cod. Barnstable Bay was full of them last fall on their way south.

19. At the south somewhere; it is not known where.

20. They feed on a sort of slime. They come north very poor and return from Maine very fat. The fish has no teeth. It has a gizzard, and the contents only equal the size of a small shot. They do not eat fish nor any vegetable.

21. They spawn here in August and September.

22. Cannot answer. We always see them in great bodies—not in pairs, or in small numbers. I think their being in great bodies, is some protection against whales, sharks, &c.

23. No, not whitened or colored.

24. Warm water in August and September.

25. At any depth, I think.

26. I suppose the spawn sinks, as all spawn tends to sink.

28. No.

29. Yes, often.

30. Almost all fish eat spawn and young fish. The parents menhaden do not. They feed as above stated. Their spawning further out at sea than formerly, must save the spawn. It used to be cast on shore more than it now is, when we had a high wind.

31. No.

32. Extensively from sharks, horse-mackerel, blue-fish, fin-back and hump-back whales, which always appear in our waters when the menhaden come. The codfish eats them night and day.

33. No.

34. Seines.

35. Two hundred fathoms long, and 10 deep

36. Sail and steam vessels.

37. Eight or 9 men in sailing-vessels—it needs that number to handle a seine; more in steamers.

38. From morning to night.

39. No.

40. I do not know that wind affects the fish, but in a high wind it is impossible to seine. You cannot purse up a seine in a heavy sea.

41. None in this immediate vicinity.

42. The fish are sent to the factories to be cooked by steam and pressed.

43. Joseph Church, Bristol, Me., made, in 1874, 400,000 gallons oil and 4,000 tons of guano; Judson Tarr & Co., Pemaquid, 235,000 gallons oil and 2,500 tons of guano; B. F. Brightman, Bristol, 280,000 gallons oil and 2,800 tons of guano; Round Pond, Bristol, 60,000 gallons oil and 1,000 tons of guano; Muscongus Oil Works, Bristol, 60,000 gallons oil and 1,000 tons of guano; Wells & Co., Bristol, 80,000 gallons oil and 1,200 tons of guano; Union, Bristol, 60,000 gallons oil and 1,000 tons of guano; J. G. Nickerson, Booth Bay, 100,000 gallons oil and 2,000 tons of guano;

Gallup & Holmes, Booth Bay, 60,000 gallons oil and 1,000 tons of guano; Gallup & Morgan, Booth Bay, 60,000 gallons oil and 1,000 tons of guano; Luther Maddocks, Booth Bay, 200,000 gallons oil and 3,500 tons of guano. There are also a number of small catchers along the coast of Maine who make oil in amounts ranging from 50 to 75 gallons.

46. Steam for cooking and steam for pressing cost all complete with seine, boats, and fixtures from thirty to two hundred thousand dollars.

47. In 1873, 60 cents. In former years not so much except at some times during the war.

48. One barrel of *good* fish makes 3 or 4 gallons oil.

50. One or 2 quarts when they first come. They should not be caught until they are fat.

51. Five gallons. It is greatest toward the close of the season.

52. Yes; a great deal more.

53. In about 1850; I was then in the fish-oil business. An elderly lady by the name of Bartlett, from Bluehill, came to my store with a sample of oil which she had skimmed from a kettle in boiling menhaden for her hens. She told me the fish were abundant all summer near the shore. I told her I would give her \$11 per barrel for all she would produce. The husband and sons made 13 barrels the first year. The fish then were caught in gill-nets. The following year they caught 100 barrels. From that time and from that circumstance has grown a business as extensive as I have represented.

54. Boston and New York. The whole country buys it for currying. It is exported to London and Liverpool, and thence to all parts of the world for currying, for soap, and for smearing sheep.

55. South, for cotton and tobacco lands.

56. Currying. It is not used for lubricating.

57. Thirty-eight to 45 cents in 1873, 50 cents in 1872; \$1.40 was the highest, a war price.

58. No.

20. *Statement of Thomas Loring, collector, Plymouth, Mass., January 24, 1874, and March 20, 1875.*

1. Pogy.

2. Average.

3. Diminished.

4. Very few.

5. It does not.

6. About the 1st of June.

7. High.

9. Never fail.

10. I think it does.

16. Yes; in September, about 4 inches long.

17. In November. I think by degrees.

19. We think south.

23. The water is whitened.
34. Gill-nets.
35. Forty fathoms long, 4 fathoms deep.
36. No vessels wholly employed in the business; only a few caught for bait.
40. We think not.
41. We do not have any vessels expressly for this business.
42. For bait only.

21. *Statement of William Atwood, light-house keeper, Plymouth, Mass., February 23, 1874.*

1. Menhaden or poggy.
6. Formerly about the 1st of May. The first are the largest.
7. They swim high and make a ripple on the surface of the water, but do not attract the birds to any considerable extent.
8. From the south. They work into the sand in bays and coves.
10. Yes.
11. They come mostly on the flood tide.
14. Yes; they prefer an even temperature.
15. They usually keep separate.
16. Yes; and are from one to one and a half inches long.
17. September, in a body.
18. Southeastern.
19. They spend the winter off Virginia, the Capes of Delaware, and in deep waters in the Gulf.
20. Suction.
31. No.
32. Very much.
33. Not on this coast.
34. Gill-nets and seines.
35. The gill-nets are from 15 to 20 fathoms long, and from 4 to 5 deep. Seines vary; are much longer than nets.
36. Propellers, steamers, and schooners, varying from 50 to 100 tons. Beside these, many small boats are employed on the eastern coasts of Maine.

There are no oil manufactories here.

Within the last ten years, these fish have diminished to such a degree that they are almost extinct in this vicinity. It is supposed that the cause of their leaving here was on account of their being frightened by the seines being placed in deep water. We hear that they are taken quite abundantly on the north coast of this State and in Maine.

22. *Statement of Heman S. Dill, Wellfleet, Mass., January 9, 1875.*

1. Pogy or hard-head.
2. They are sometimes very scarce.
3. Diminished.
4. In 1873, I do not know. About six thousand barrels in 1874, in this bay ; there is no sale for them in the spring here.
5. I think not.
6. About the middle of May ; they are small in the spring and large and fat in the fall.
7. They swim high ; are seen in shoals.
8. They come from the south.
9. Quite regularly, about the same time of the year.
10. I think seines are a damage ; gill-nets do no harm.
11. The ebb tide they show themselves the most.
12. It seems to me that shoal water or eel-grass bottom, or close in shore, are their favorite localities.
13. You see them in all depth of water.
14. I think it does ; they will not stay in cold or warm water ; I think they will stay in cold water the longest.
15. We find those of different ages together.
16. They are seen quite plentifully here in August and September, from three to five inches long.
17. They leave by degrees, and are not all gone until September.
18. They leave by passing to the east of Cape Cod.
19. Somewhere in the South, or near the edge of the Gulf.
20. Some small shrimps of a red color we find inside.
21. They spawn here in May or June.
22. They are generally all together, as far as I know.
23. I never saw anything like it.
24. Quite a low temperature.
25. From three to five fathoms in this bay.
26. They are, I think, attached to stones or grass.
28. They are found here in considerable abundance sometimes ; I have seen them in shoal water for two months. The blue-fish then drove them out, or they would have remained there for two months longer. They grow from two to three inches while in this shoal. I have noticed them grow from day to day.
29. It does, sometimes.
30. I think most kinds of fish devour them. I think crabs destroy a great many.
31. I never saw anything of the kind.
32. Blue-fish will drive them into creeks and bays, and finally drive them off the coast entirely. They used to stay here all summer in Barnstable Bay ; now they stay but three or five weeks, in May and in the first part of June.

33. I never saw anything of the kind.

34. Seines and gill-nets and weirs.

35. The gill-nets are 40 yards long and 6 yards deep.

36. There are no vessels employed anywhere here.

37. The men stay on shore and arrange their nets and the weirs. There are plenty of them here; one weir caught 4,000 barrels in one night this fall.

38. In the first part of the day; sometimes all day.

39. At low water or slack tide.

40. I do not think it does.

41. There are no vessels employed here.

42. Some sliver them for bait; some try them out for the oil, and send it to Boston.

43. There are a few small places here; J. Sparrow, P. Smith, I. H. Horton, and some other places around the bay.

44. Not over 20 barrels; they do not carry it on only in the fall.

45. * * *

46. About one hundred dollars; that is, for press, kettle, house, and fixtures.

47. Fifty cents per barrel. The same price in other years.

48. It takes one barrel to make three gallons of oil.

49. About 5 barrels.

50. Three gallons, I believe, is the least.

52. Yes.

54. Boston.

55. Sometimes it is used here and sometimes it is sent to Boston.

57. In 1873, 55 cents; in 1874, 33 cents.

58. If there was no blue-fish I could tell better; there are not half as many now as there were. There used to be plenty all summer; now there are only a few during that season. I have been in the fishing business for forty years. There are not so many of the sort of fish referred to now as there used to be. I have seen, in this vicinity, the water alive with them; the cause of their scarcity at the present time is the prevalence of bluefish. The pogies stop for a short time only. They pass here in the spring bound north; in October they return again, and stay here about a month. They do spawn here in the spring. I have seen them here five inches long. I have seen barrels of them in the weirs; they would stay in there for two months; the bluefish would keep them in. I think bluefish are their worst enemies. The weirs use up all kinds of fish; one weir caught four thousand barrels of pogies and hardheads in one night this fall. To sum up the whole matter, there are not half so many pogies as there used to be. They do not stop here long enough for us to make a business of catching them. I think seining is a damage to all fishing.

23. *Statement of David F. Loring, Highland Light-Station, North Truro, Mass., March 2, 1874.*

1. They are called pogies.

2. They are full as plenty from the last of April to the middle of May as any fish that I know of; during that time they are passing in by the cape into the bay, coming from the South. They follow the shore down to the coast of Maine. Whether they go farther to the eastward than the coast of Maine, I do not know; but presume they do certain parts of the year.

3. Apparently not one-half as plentiful as they were ten years ago.

4. There are very few taken at this part of the cape for their oil; about all that are taken are what the fishermen catch for bait for catching codfish, dogfish, &c.; probably all that are taken by the fishermen during the year at this place and Provincetown does not exceed 2,000 barrels. I believe there are a few establishments, for extracting the oil, farther up the cape at Eastham and Dennis; the number of them, and the quantity of oil they get, I do not know.

5. The opinion of people generally seems to be, that they will become extinct in a few years if they continue to be taken for the oil.

6. From the last of April to the middle of May.

7. They first make their appearance in large schools on the surface of the water.

8. I do not know how far to the south they strike the coast when they are coming to the North in the spring. They come in by Block Island, and come through Vineyard Sound, or Martha's Vineyard (so called), as they catch thousands of barrels in the fish-weirs that are built along the north shore of the vineyard. After passing by the cape in the spring, they frequently make their appearance in Cape Cod Bay, through the summer, with the bluefish chasing them; where they come from it is impossible to tell. Whether they come from the eastward, or whether they are new bodies come from the South, I do not know. I have seen hundreds of barrels of them lying along the shore in the western part of Provincetown Harbor that were driven ashore by the bluefish.

9. I do not know as there is any great difference in the schools from year to year, but they *are* decreasing because so many of them are caught for their oil. I presume there has been years when they did not make their appearance, but not within my recollection. I think they are very regular in their habits.

10. I do not think the use of set nets makes any change in their movements, as they are used for catching the fish in the night; but I think the use of the seine has a tendency to frighten them. I know that seining does frighten mackerel, and do not see any reason why it should not frighten pogies.

11. Very seldom see them schooling on the ebb-tide; but as soon as the tide turns flood they commence to school on top of the water. I

have seen the surface of the water literally covered with schools on the flood-tide, while on the ebb there was hardly a fish to be seen. I have seen them under water on the ebb-tide, two or three fathoms down, in schools; but they move very slowly until the tide turns flood; then they school up on the surface of the water, and are quicker in their movements. I have seen them in the fall of the year, when not schooling; but whether schooling or not, they generally play on the surface of the water, except on the ebb-tide.

12. Around the islands and harbors on the coast of Maine.

13. During the summer season generally find them very near the shore, near the surface of the water or a few feet below.

14. It does not.

15. Never noticed young fish with the old ones; very seldom see the young fish after the first year until nearly full grown.

16. Generally see the young fish in October; they are then about three inches long.

17. They commence to move south about the first of October; leave the coast by degrees.

18. I do not think the main body follows the coast in the fall, after passing Cape Cod, as they do when they come north in the spring. I believe the main body, instead of going through Vineyard Sound and following the coast, go out through South Channel and go wide off shore, but presume they strike in on the coast farther south.

20. What the fishermen call cayenne, a sort of fine, red substance floating in the water. Mackerel feed on the same.

21. I think, from observation, they spawn where there is plenty of eel-grass, in localities where they are not apt to be disturbed by bluefish. Their spawning season is about the last of June.

22. I have seen them when they were spawning; they get together in bunches, from twenty to five hundred in a bunch, more or less, in shoal water, over a body of eel-grass, and then swim around in a circle, pressing against each other as they swim. I suppose they deposit their eggs on or among the eel-grass.

23. It is not.

24. Do not know the temperature of the water, but when they spawn the water is quite warm.

25. Where I have seen them spawning it would not ebb quite dry at low water.

26. Presume they become attached to the eel-grass.

27. Do not know how soon they hatch after being deposited, but probably not a great while, as in October the young fish are from three to four inches long.

28. When they make their appearance in October they are very plenty. I have seen the fishermen catch them with dip-nets, for bait. They act very much like the old fish, being in schools or bodies. I never happened to notice them anywhere except in Provincetown Harbor.

29. I never noticed it to be so.

30. I cannot say positively whether the parent fish devour their young or not, but think not; there are, however, many of their eggs destroyed by fish that live on or near the bottom of the sea, such as flounders, sculpins, perch. Sharks and bluefish destroy many of the young fish.

31. Have never seen anything of the kind.

32. Probably the sharks and porpoises destroy many of them, but bluefish are their worst enemy; they destroy an immense number of them every year.

33. Never knew or heard of any disease among them. I have seen them in the mouth of the Merrimac River in immense quantities, schooling; they are probably destroyed in immense numbers along the coast every year by the fresh water coming down the river.

34. Set-nets and seines.

35. The nets are from fifty to eighty yards in length, and from fifty to a hundred meshes in depth; the meshes are from four to four and a half inches in length.

24. *Statement of David F. Loring, Cape Cod Light-Station, North Truro, Mass., February 23, 1875.*

1. Pogy.

4. Do not know the number of barrels taken during the year 1873, probably not over a thousand in this vicinity; but during the fall of the year 1874 there was some thirty thousand barrels taken by small steamers with seines. These steamers belong to a company in Fall River, Mass. This company has a large establishment or oil-factory at Booth Bay, Me., where they carry on the business very extensively during the summer season. After the pogies leave the coast of Maine and start south the steam seiners follow them. After leaving their establishment in Maine in November, 1874, and while crossing Massachusetts Bay, the steamers took a fresh breeze and came into Provincetown Harbor; and in going out of the harbor to go around Cape Cod, after the storm, they fell in with pogies in the bay, and took 30,000 barrels in four or five weeks. I believe the fishermen in this vicinity have an idea of going into the business quite extensively the coming season; it will probably be the beginning of a large business.

10. It is doubtless a fact that these fish are driven away from the shore by the use of seines, especially in localities where the seining business is carried on extensively; as, for instance, the coast of Maine, where, a few years ago, the seiners could get all they wanted close in along the shore; now they have to go from thirty to fifty miles off-shore to get the fish. I am informed by old fishermen, who have been engaged in different kinds of fishing on the coast of Maine for the last fifteen or twenty years, that while these fish do not go in along the shore as they used to, they are very plentiful off-shore, but not as plentiful as they were ten years ago; and they agree with me that it is the seiners

that scare them away from the shore, and that they are fast diminishing in number.

21. I have seen them while spawning in the harbor at Provincetown. They get where there is plenty of eel-grass, in from one to three fathoms of water.

22. They get together in bunches or small schools, a barrel or two, more or less, in a school, and swim in a circle pressing against each other.

23. It is not.

50. When they first make their appearance on the coast in the spring of the year they are very poor. I think they will not average more than two quarts of oil per barrel of fish as they are taken from the seine.

51. About four gallons oil to a barrel of fish in November.

58. If it is a fact that these fish are scared away from the shore by the use of seines, and also that these fish do deposit, and if it is natural for them to deposit their spawn on seaweeds and rockweeds along the shore, and from my own observation I think they do, it then follows that they are driven away from their spawning as well as their old feeding grounds, and, as in regard to salmon and other fish that have been driven away from their natural spawning-grounds, they naturally will diminish.

25. *Statement of Josiah Hardy, 2d, Chatham Mass., February 17, 1874, and January 9, 1875.*

1. Menhaden or pogey.

2. They are more numerous than any other fish.

3. As to their diminishing within the last ten years there have been various opinions; but my opinion is, nor do any now deny it that they are less than they were in years previous to this period. These fish used to enter our bay and line the shores and fill up our inland bays and ponds in immense quantities even to their own suffocation. About the year 1832 they were so numerous on and about this coast, and filled our harbors and the mill and oyster ponds so full they suffocated, and thousands of barrels of them drifted on shore. So many were they, that the inhabitants of this town were summoned to bury them lest a pestilence might arise. The same thing occurred a few years later; then there was no use for them, but they were used for dressing on the land. Since that time, as well as then, any quantity could be had for this purpose.

4. For the last five years about 3,000 barrels each year.

5. Between 1835 and 1840 the mackerel fishermen began using fish for bait, and large quantities were seined for this purpose. Since that time they have diminished to such a degree that very few have entered our harbors and ponds during the last few years. The most of those

which do enter remain through the season. These menhaden are only on their way to the eastern shores, coming from the west when they strike this bay. They come in large schools, and are followed by numerous sea-birds.

6. They have been caught in our bay as early as the 15th of April, but they generally come about the 1st of May.

7. It depends upon the wind. They are generally seen in schools, and they attract sea-fowl.

8. They come from the westward through Vineyard Sound and around Nantucket Island. They come in shore at high water; at low water they keep in the channel, which is from three to seven fathoms deep. I do not think the depth of water affects them very much. They are as regular in their course and movements as a flock of sea-fowl. When one is frightened, they all start; if one turns, all turn; if one goes down, all follow. They have one peculiarity for which we cannot account. Sometimes for hours not a fish can be seen, and then suddenly they rise to the surface and the water is full of schools, sometimes swimming in a circle and sometimes headed in the same direction.

9. I never knew them to fail.

10. Yes.

11. At high water they enter the rivers and follow up into shoal water; on the ebb, they go off into deep water.

12. Rhode Island, Chatham Bay, and the eastern shore of Maine.

13. They school in any depth, and generally near the surface, unless attacked by some enemy.

14. Yes; during northerly or cold winds they swim deep, while during southerly or warm winds they come to the surface.

15. They do evidently mix with fish partly grown.

16. They are in July and August. When some schools get into our inland ponds and stop through the summer, we see the young ones about two inches long and shorter.

17. The fish pass here from south in the latter part of September and first of October. All move about the same time.

18. They follow the shores of Cape Cod.

19. On the southern coast.

20. They apparently live by filtering the water through their gills.

22. They go in large schools, but are never known to pair.

23. No.

29. The oldest pogy fishermen say they never saw any spawn in them, but have seen what they called young pogies.

30. They are a prey to sharks, dogfish, squid, codfish, bluefish, hali-but, and porpoises.

31. Nothing of the kind was ever seen on them here.

32. The bluefish are their great enemy, and they leave when this enemy comes.

33. I cannot find a man who ever saw a diseased menhaden.

34. Weirs and gill-nets.
35. Twenty-five feet deep and of different lengths, with pounds or traps at the ends. Gill-nets are 115 feet deep. Sweep-nets are 150 fathoms long and 25 deep.
36. There are no vessels in the business.
37. Ten men to a seine or weir.
38. Four hours each day.
39. More on the ebb than on the flood.
40. It does. The warm southwest winds are the most favorable.
41. There are none.
42. They are sold to the Gloucester codfish fleet and to spring-mackerel fishermen for bait.
43. There is no oil establishment here.
47. About \$1.50 in 1873.
48. The season makes a difference. In the spring they are very poor and in the summer and fall very fat.
55. A guano factory on Vineyard Sound.
58. It does not diminish them perceptibly. We have in our bay (1875) thirteen fish-weirs within twelve miles, which are set from the 15th of April until the 1st of June. These weirs are set in from two to five fathoms of water. We catch all kinds of fish, for if the leader of a school falls into our traps the rest follow, and thus tons of fish of all kinds are taken.

26. *Statement of Alonzo Y. Lothrop, Hyannis, Mass., February 18, 1874, and January 1, 1875.*

1. Pogy.
2. Favorably.
3. Greatly diminished.
4. Not many in the immediate vicinity; large numbers east and west.
5. It does, apparently, in this section.
6. In May and September.
7. They swim high and make a ripple; attract sea-gulls and other birds.
8. From the Gulf Stream. They follow up rivers and bays. Have caught them in "dip-net" two miles up Shoal River in two feet of water.
9. Regular and certain.
10. No.
11. All fish more abundant in this section on "flood."
12. From New York to Maine, near shore, rivers, bays, and bends.
13. Shoal water.
14. Leave the coast in cold weather.
15. Yes.
16. Never noticed. Have seen resemblance in smaller fish.
17. In September or October. Should say in a body.
18. Southern.

19. In warm water ; probably in the Gulf Stream.
20. Friars, shrimp, and minnows.
22. Think they mix indiscriminately.
23. I never saw the water colored.
26. I think they float in the water until hatched.
28. Not abundant in this section.
29. Yes.
30. Sea-gulls and other birds ; besides sharks, dogfish and bluefish.
31. Have noticed quantities of crabs in same seine with pogies.
32. They suffer fearfully.
33. Have noticed them lying dead on the shore. I suppose they were carried up by shoal water or by sea-weed.
34. Purse-net with small mesh.
35. Various. Some 1,000 yards long and 6 fathoms deep.
36. Steamers, schooners, and sloops.
37. Ten to thirty.
38. Morning.
39. Flood.
41. None in immediate vicinity.
42. Mostly to oil factories.
43. None ; one at Wood's Holl.
47. From 30 to 50 cents per barrel.
48. One barrel, about.
50. One gallon.
53. Until within a few years pogies were used by mackerel catchers for bait, ground in bait-mill on board of vessel, and fed out to this class of fish (mackerel) to raise them to surface of water. They are then caught by hook and line. Within a few years oil factories have been established, taking in a large territory, and carried on on a large scale at the present time.
54. Cities.
56. Painting purposes.
58. I should say they had not diminished.

Menhaden, or pogies, as they are commonly called in the Eastern States, were found in unusually large quantities during the year 1874, apparently an increase in their numbers. One steamer alone carried into Linniken's Bay (near Booth Bay, Maine) nearly 25,000 barrels. Taking into consideration the large number of vessels of various kinds connected with the business, immense quantities of these fish must be used up yearly, but still they come.

27. *Statement of William S. Allen, Nantucket, Mass., January, 1875.*

1. Menhaden.
2. Comparison small.
3. No observable change.

4. About 12 barrels; by lobstermen for bait; none previously taken.
6. October; all arrive nearly at the same time, dividing into, say, four schools, all seen at once.
7. Mostly high; make a ripple; attract birds.
9. Since first noticing them their appearance has been nearly regular in time and numbers.
10. Their capture is not pursued here.
11. Seen mostly on the flood.
13. Unknown; both high and low.
14. Yes.
17. At the first change to coldness—in a body.
20. Animal.
23. Sleaked, or greased.
26. Probably float.
30. Bluefish.
40. Yes.
41. None.
42. All use baiting purposes.
43. None.
56. A quantity is used in paints.
58. Probably.
61. January 3, 1875.

28. *Statement of R. C. Kenney, Nantucket, Mass., January 21, 1874.*

I have the honor to acknowledge receipt of your communication of the 20th ultimo, relative to "Statistics of the Menhaden Fisheries, &c.," and herewith transmit such information as I have been able to obtain on the subject.

1. Pogy.
2. More numerous than any other kind of fish.
3. They vary from year to year, but as a whole, for the past ten years remain about the same.
5. It does not.
6. They appear about the 1st of May, or if the season is early, a little sooner. Are most abundant in June and July; the last run are the largest and fattest.
6. They gradually increase in abundance from the first.
7. Swim on the surface, causing a ripple, and do not appear to attract birds as other fish do.
8. When they appear in *our vicinity* it is from the direction of Sandy Hook and the Jersey shore. By *our vicinity*, I mean from the entrance to the Vineyard Sound, around Cape Cod.
9. Their appearance in large numbers is not regular or certain. When they fail to appear for a season the next year is usually a good one;

above the average. I think the prevalence of strong southerly winds favorable to their return.

10. It does not.

11. The tide has no apparent effect upon them.

12. Cannot name any definite locality.

13. Have seen them in deep and in shoal water. They usually track the shore.

14. They appear to prefer warm weather. A cold turn will drive them off.

15. When taken in any quantity there appears to be a mixture of old and young.

16. We frequently see them in the fall of the year, from 3 to 4 inches in length.

17. They commence leaving the coast about the 1st of October, and disappear altogether in November.

18. They return by the same route that they came.

19. I am not certain but think they go to the edge of the Gulf Stream.

21. Judging from the number of small fish seen I should say they spawned around our shores in June and July.

26. I think they sink to the bottom and become attached to stones, &c., like other spawn.

29. Yes.

31. Have sometimes seen lamprey eels attached to the outside.

32. Sharks, sword-fish, porpoise, and bluefish are very destructive to them.

33. I know of none.

34. Purse-nets, gill-nets, generally; sometimes by sweep-nets and fish-wears.

35. Purse-nets are from two hundred to three hundred fathoms in length and from fifteen to thirty fathoms in depth. Gill-nets are about seventy-five fathoms in length and from two and a half to three fathoms in depth.

36. In this vicinity sail-boats of about 5 tons' burden are used for setting the nets.

37. For a purse-net about eight men are required; for a gill-net one man with a dory; for a fish-wear from seven to eight men.

38. The gill-nets are set nights; the others through the day.

39. No difference.

40. I think not.

42. About one-half are put on board our fishing-vessels to be used as bait in the cod and mackerel fisheries. The balance are sent to the factory at Woods Holl, Mass.

43. The nearest factory is at Woods Holl, Mass. The owners are unknown to me.

47. The price per barrel, for some years past, has been from fifty to seventy-five cents, as taken from the nets.

52. They do.
 56. Used for tanning purposes.
 57. From forty to fifty cents per gallon.
 58. I cannot see that they diminish under any circumstances.
-

29. *Statement of C. B. Marchant, collector of customs, Edgartown, Mass.,
January 13, 1875.*

1. This species is known in this locality by the name of menhaden.
2. They are more abundant here than any other species of fish.
3. Their numbers have not materially decreased or diminished during the last ten years.
4. There were about 5,000 barrels taken here in 1873; in 1872, 10,000 barrels. The following companies and persons are engaged in their capture: Jason Luce & Co., Richard Flanders & Co., Prince Stewart & Co., Edwin A. Luce, Thomas Norton, Edmund Cottle, and John Look.
5. Their capture does not affect their abundance.
6. They come on the coast the 1st of May; other schools at intervals to the middle of June. The first caught are not the largest taken during the season.
7. They swim near the surface, ripple the water, and attract birds.
8. They enter these waters from the southwest.
9. They frequently fail for one or more seasons, but return again in usual numbers.
10. Pounds used for their capture appear to scare them.
11. More fish are caught on the first of an ebb-tide than at other times.
12. Their favorite locality in this vicinity is the Vineyard Sound.
13. They are found in greatest numbers in deep water near the shore, and on the surface of the water.
14. They seek water of the highest temperature.
15. All fish seen are of full growth, or nearly so.
16. Young fish are not often seen on this coast.
17. They leave this vicinity about the middle of July, and return in small numbers in November.
18. They are moving to the eastward.
19. Unknown.
20. Unknown.
29. The spawn is often found to escape when captured.
30. The bluefish destroy the spawn; the parent fish is not known to devour them.
31. Crabs, worms, &c., not observed attached to gills or mouths of these fish.
32. The enemies of these fish do not perceptibly diminish their numbers in this locality.

33. No fatal epidemic or disease has been observed among these fish.
 34. The method of their capture in this locality is in pounds.
 35. The dimensions of these pounds are about 1,200 feet long by 28 feet wide.
 36. No vessels are employed in their capture.
 37. Forty men are engaged in their capture.
 38. These men are employed all the time during the season of fishing.
 39. The fish are taken principally on an ebb-tide.
 40. A southwest wind the most favorable for their catch.
 42. The fish are sold to vessels on the spot for bait.
 43. None.
 47. The price per barrel, in 1873 and previous years, averages 50 cents.
 58. The catch of these fish does not appear to diminish their number.
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30. *Statement of Jason Luce & Co., North Tisbury, Mass., January 6, 1875.*

1. Menhaden.
 2. They exceed others.
 3. Diminished.
 4. Five thousand.
 5. No.
 6. About the 1st of May, and the first are the largest.
 7. They swim high, make a ripple and attract birds.
 8. They come from the south and go west.
 9. They are sure to come.
 10. I think not.
 19. South.
 20. Suction.
 21. South, in the winter.
 30. Bluefish. No.
 31. I never saw anything of the kind.
 32. Bluefish make great havoc with them.
 34. Purse-nets.
 43. Pacific Guano Company.
 50. Least in June.
 51. Greatest in November.
 56. Used for paint.
 58. No.
-

31. *Statement of Gallup, Morgan & Co., Groton, Conn., December 28, 1877.*

We have two steamers; the Daisy and the John A. Morgan; tonnage respectively, 66, 87; 14 men each crew. Length of seine, about 230 fathoms; depth, 25 fathoms. Number of barrels of fish taken, 24,000.

32. *Statement of Luce Brothers, East Lyme, December 4, 1877.*

We have one steamer, 76 tons burden; 9 sloops, 19 tons burden; 4 crews of 12 men each. We employ 40 men in our mill. Seine, 150 fathoms long, 18 fathoms deep. We have taken 23,800,000 fish; made 2,400 barrels of oil, or 103,200 gallons.

33. *Statement of Daniel T. Church, Tiverton, R. I., March 23, 1874.*

1. Menhaden.

2. There is no fish so plenty in Narragansett Bay as menhaden if we take several years as the standard; but if we should take years as they come, and name each year separately, it would be different. For instance, during 1871, 1872, and 1873 scup appeared in Narragansett Bay in immense quantities, and there is no doubt in my mind but that there has been during the years named more of them than menhaden; but for a number of years preceding scup were scarce.

3. Menhaden has, on an average, been plenty in Narragansett Bay for the last ten years. But for about ten years they were so scarce that some of the fishermen left the business. It is my opinion that when bluefish were plenty they destroyed such large quantities that there was a vast diminution, and it was seriously feared that they were to disappear; but since the bluefish have grown scarce menhaden have grown plenty, and 1871, 1872, and 1873 have been great years in the business for bluefish. Sharks and a large fish called horse-mackerel have been for some unknown reason scarce. The horse-mackerel spoken of does not frequent the waters of Narragansett Bay, but are found east of Cape Cod.

4. Taking for a basis of estimate that there are eight menhaden factories on Narragansett Bay that used 20,000 barrels each, it would make the number of barrels caught during year 1873 about 160,000, and I think the above estimate about right.

5. We do not think that fishermen have any perceptible effect on menhaden, for it is a fact well known that a few years back they were scarce and it was generally conceded that the business was a failure, and some left the business because of the scarcity, and fish-gear, such as boats and seines, were sold for less than fifty cents on the dollar. But since then they have been plenty, and the year 1873 has been a year of surprise to all, for the sea has been one blanket of menhaden from the Chesapeake to the Bay of Fundy.

Menhaden strike the coast not far from the first of May, and there is not many days' difference between their arrival on the coast of Virginia or Maine. It is the opinion of those best informed that menhaden go to sea in winter and come in during the spring. I once had a brother in

Virginia fishing, and at the same time I was at Seconnet fishing, and there was not three days' difference between their arrival in the Chesapeake and the Narragansett Bays. The strongest proof of the correctness of the above theory is that there is a body of menhaden from one end of the coast to the other during the whole season ?

7. It depends upon the weather. Fish make a ripple in the water. When it is warm they generally are near the surface and when it is cool they swim deep.

8. It is my opinion that the fish go square out to sea from one end of the coast to the other, although their general course when first seen is toward the east. But if they all went east, how is it that so many are from one end of the coast to the other during the whole season.

9. I have never known a season that they have failed to make their appearance. Their time of arrival varies as the season is warm or cold. I have been at Seconnet for seventeen years in succession, and every season they have come sooner or later, but in different quantities, for some seasons they are much more plentiful than they are others.

10. The nets and seines do not scare them from the shore, for Narragansett Bay has been the theater of their greatest capture for forty years or more, and they have been more plentiful than ever before for the last few years. I have seen a school of fish set out ten times in succession in deep water and they would dive under the seine each time, but when they came to the surface they would not be ten feet from the seine, and they would lie still until we got ready to set ; when the seine was around them they would dive again.

Fish will drive menhaden but man never does, except by use of powder ; they are sensitive to a jar, such as hitting the deck of a vessel with an ax ; even so slight a jar as the dropping of an oar or the careless slat of a rung on the gunwale has sent a school of fish off at full speed.

11. They drift with the tide sometimes, and then again they swim against it. I have seen them in Dutch Island Passage, which is the western entrance to Narragansett Bay, drift in and out with the tides as regular as it ebbed and flowed. At the first of the flood they would come in and work up as far as Rocky Point, and when it made ebb they would drift down near Narragansett Pier.

12. I know of no favorite places. We hear of them on George's Banks, on Nantucket Shoals, off the coasts of North Carolina and Virginia. I have seen immense schools of them off the coast of South Carolina, and we all know they are in all the rivers, bays, and creeks from South Carolina to the Bay of Fundy during the summer months.

13. I think they care nothing about depth of water, for they are found in large quantities in deep and shoal waters. We catch large quantities on the coast of Maine in 50 fathoms, and even in 100 fathoms ; and at the same time there are large amounts of them in the rivers and bays in shoal water.

14. The temperature of the water does seem to affect them ; they do

not seem to like cold water. When it gets to be cold weather they leave, and I reason from this that the air makes the water cold, and then they start. But they go onto the coast of Maine, and keep in the cool, deep water, when, if they liked, they could soon be in warm and shoal water. Why they do so is more than I know; but there seems to be difference of habit, for some stop in the deep and cool water while others go into the shoal and warm water.

15. I know nothing of their habits or laws of breeding, but I do know that we rarely see any of them with spawn in them, and when so found it generally is in the fall. But we have abundant evidence that they do spawn in this bay, from the fact that often we take in our nets bushels of their spawn, and also during some seasons there are large quantities of small fish about the size of sardines. They are always seen in the fall. We know nothing of one or two year old fish; they are either full grown with us or small. But there are different sizes of fish, as we find by our nets, for we use a mesh $3\frac{1}{4}$ inches large, and sometimes we catch a school that "gill" in them, although not often. We take schools of fish that are large and overgrown, but we generally think it to be due to the difference in their feeding grounds.

16. Now and then there are plenty of small menhaden in Narragansett Bay, but it is the exception instead of the rule. I never saw any young menhaden east of Cape Cod, and I have asked a man that has fished constantly for menhaden east of Cape Cod for about ten years, and he says he never saw any. I have seen plenty of them south of Narragansett Bay.

17. It is hard to tell when the fish leave the coast, for we can fish with our purse-seines and have good fishing if it is good, warm weather, but if it comes on cold, the fish vanish, and to all appearances they are gone, for they do not show on the surface of the water; but the gill-nets will take them long after, and they have been so taken as late as New Year's, when they are quite plenty; this shows that they are not gone at that time. Who knows but what they are close by all winter?

19. We don't know where they spend their winters, although I have seen large quantities off the coast of South Carolina and North Carolina during the winter months.

20. I don't know the nature of their food, except we think it is a small live something in the water, for they go about with their mouths open, as if sifting or straining the water for food. We call it brit. It must be something of great fattening properties, for they fat rapidly when they arrive on the beds of it that lie off the coast of Maine.

21. I know they spawn on Narragansett Bay.

28. They are abundant some seasons in this bay, but not always. I have seen millions of barrels, about the size of sardines; and on the coast of North Carolina I have seen them for miles square so plentiful, about the size of sardines, that you could hardly move a boat through them, and an oar among them would fall down about as fast as

a stick would in thick molasses. The havoc that gulls and fish make among them is fearful when they are together in such bodies.

32. They are the bait or food of most every fish in the sea. Bluefish is the menhaden's great enemy, for when they attack in large quantities, and they used to come apparently about as plenty as the menhaden, they annihilated vast schools of them. Instances are known when they came into this bay in such force that they drove them on shore in large quantities, and in a short time most there was in the bay would be destroyed. The record here is the same from one end of the coast to the other. Cape Cod Bay was cleaned out, as were the rivers and bays on the coast of Maine, and the destruction was so large in some parts of Maine, that the people had to bury them from the fear of a pestilence. The same story is told at Long Island, and also on the Connecticut shore. The sharks destroy them. I once saw a body of them destroyed or scattered in less than one hour. This was off Seconnet. They were lying there apparently undisturbed, when suddenly a large school of sharks appeared among them, and the havoc was fearful. One gang of fishermen had their seine in the water, and the sharks destroyed it; they were so ugly, that they would grab an oar in the water as quick as they would a fish. Porpoises are fond of them, and they can do as much destruction as any fish, but they are not often seen around here. Cod-fish also catch them.

33. I know of no epidemics, but I have heard often from old people how that years ago most all the menhaden in the sea and in the bays died, and for a year or two they were scarce.

34. Purse-nets at present are used mostly to capture them.

35. About 180 fathoms long and 80 feet deep, although some are 250 fathoms long and over 100 feet deep; while others, on the other hand, are not over 75 fathoms long and 50 feet deep. The length and depth of seines depends on the depth of water and the kind of fishing.

36. Steamers and sailing-vessels. The largest steamers are 70 tons; the smallest, 25 tons. The sail-vessels usually are about thirty tons, new measurement, and are used generally to live in. They have tenders to take the fish to market; said tenders are of an average capacity of two hundred and fifty barrels, but latterly they are built larger, and there are some in use that will carry six hundred barrels. Besides the tenders and vessels, there are the purse and mate boats, which carry the seine and men. These boats are about twenty-four feet long and six feet wide, and take on half of the seine each; they are then started from a central point and row around the fish.

37. The sailing-vessel has a captain, who manages the vessel when the men are absent taking the fish. The purse-crew, which man the purse and mate boats, consists of six or eight men. The purse-boat contains the captain of the gang, and the mate-boat has the first mate. Each boat has a seine-setter and two men to row around the fish. In addition to the above men, most of the gangs have a fish-driver in a

small boat, who keeps close to the school and guides the gang in setting for them. The fish-driver makes the seventh man. Some gangs have a man they call a striker. Generally, he is an apprentice, who goes for small wages to learn the business. He makes the eighth man. To recapitulate: A purse-gang, for either steamer or sail-vessel, consists of from six to eight men, and the different make-up of gangs arises in different ideas of different gangs. Each boat has to have a seine-setter and two men to row. Steamers have the same crew as vessels, except they have no tenders, thereby saving that expense. To illustrate: Suppose a sail-vessel has a purse-gang of seven men and three men to run tenders; that makes ten men in all as sharesmen. In a steamer the three extra men are dispensed with, and the steamer takes their part for the extra expense of coal and machinery, but the men's shares are the same on an equal amount of fish. The captains of the steamers manage them when the crew are absent catching the fish.

38. All parts of the day are used in taking them, but the moderate part is preferred.

39. The tide is watched in catching fish. Generally, slack water is the time when they can be taken the best, for at that time the seine is not scraped over the bottom, thereby escaping the chances of catching against obstructions and tearing. Cases have happened where seines have been totally lost, and hardly a day goes by when one or more are, in fishing language, ripped up; and sometimes it takes a week's steady work to mend them. When the water is still, the seine hangs better in the water. It is just the same as hanging clothes out to dry on a windy day—the stronger the wind, the more they shake; so with seines; if they are put into the water with it in swift motion, they are capsized or pulled out of shape; for when they are in the water and swing one hundred feet deep, they are in more than one kind of tide, for often the tide on the surface is not of the same velocity as it is deeper down. Cases have been known when the tide on the surface and the tide several fathoms down were opposite. I have often heard the fishermen say when they came in after a hard day's work, that "we have done nothing to-day; strong tide, and our seine capsized every time we placed it."

40. All the effect we know is that the wind makes the water rough, and we cannot catch them; but I do not think the wind has much effect on them as to their habits or to drive them away, for after the hardest storms we have ever known on our coast, the fish are found where they were when the storm came on.

41. There were about ten gangs employed in Narragansett Bay for the whole season, and there were not far from one hundred men employed in working them. I leave out of this estimate those gangs that fit here in the spring, and go east and fish the whole season. My business is mostly in Maine, and in my vicinity there were fifty-five gangs, which employed over six hundred men. More than one-half of these men came from Rhode Island. Most of them fish there a short

time in the spring and fall, but the main part of their season is off the coast of Maine.

42. Most of the fish caught by the above gangs are manufactured into oil and fish guano; some are used for bait and some are used for manure just as they are taken from the water. But during the year 1873 there was but few of those caught in Narragansett Bay used for bait, because the Gloucester and Provincetown fishermen catch them with their own seines.

43. Job T. Wilson, Leonard Brightman & Son, Wm. J. Brightman & Co., Narragansett Oil and Guano Co., Thomas Dunovan, Thomas Durfee, Benjamin H. Gray, Otis Almy & Co., Chas. Cook & Co., Chas. O. Wilcox, Atlantic Oil and Guano Co. are the principal manufacturers on Narragansett Bay. The above list comprises all there are in the bay. Job T. Wilson owns three and Leonard Brightman owns two factories.

44. If my estimate is correct under question four, 160,000 barrels, at the usual estimate of 3 tons to the one hundred barrels, would give the amount of guano 4,800 tons, and the oil, at the rate of $1\frac{1}{2}$ gallons of oil to the barrel, would give the product of oil for this bay at 240,000 gallons.

45. I should think the average productive capacity of our oil factories to be about six hundred barrels each; as I figure it some will manufacture one thousand barrels each day, and some will not manufacture more than two hundred barrels per day. The productive capacity for each year is immense, but the amount of fish limits it to what the figures before given will give. If all the factories had all the fish day by day that they wished, and could run from one end of the season to the other, their product would flood the world, but there are so many set-backs, such as bad weather, sharks, bluefish, that these fishermen get discouraged and go at other work. Take it all in all, there is no business on earth more uncertain than menhaden oil business.

46. Hydraulic power is mostly used in pressing oil and water from fish. Steam is used mostly in preparing the fish for the press, and also the oil is prepared by steam for market by a process not generally known. A hydraulic press costs about \$12. A factory, complete, ready for business, including buildings, tanks, boilers, oil run, &c., of a capacity to take and press 800 barrels in one day, costs not far from \$14,000.

47. Fish per barrel on Narragansett Bay was, during the year 1873, about 40 cents; in 1863, during the summer, \$1 per barrel; and once within ten years they were \$2.50 per barrel. On the coast of Maine the price paid for fish during the year 1873 was about 72 cents; the old price used to be \$1, but the low price of oil and guano for the last few years has caused them to fall, and the year 1873 has been disastrous for most of the manufacturers on the coast of Maine.

48. In 1871 fish averaged on the coast of Maine $3\frac{1}{2}$ gallons per barrel; in 1872 they averaged $2\frac{3}{4}$ per barrel; in 1873 they averaged about 3 gallons; the average is more uniform in Maine than on Narragansett Bay or in Long Island Sound.

49. There is no oil extracted from scrap; the oil is extracted from the fish and the water is extracted at the same time, and what is left is scrap, or, as we call it, fish-guano.

50. Fish are generally poorest in the spring when they first appear next to the shore; after cold winters they are much poorer than after warm winters, which shows that during warm winters they feed more than they do in cold winters. I have seen them so poor in this bay in the summer season that out of one hundred barrels we could not get one pint of oil; then, again, I have seen them so fat that the average would be over two and one-half gallons to the barrel.

51. The fish are fattest generally in the fall, but I have known them after a warm winter to make $2\frac{1}{2}$ gallons to the barrel. But the first 18,000 barrels caught by us in Maine during the year 1873 did not make over 14,000 gallons of oil.

52. During the year 1873 the average to the barrel in Maine was one-half of a gallon more to the barrel than in Long Island Sound, and one gallon and one-half more than the average in Narragansett Bay.

53. But a few years back there was no such thing known as menhaden oil and guano business; at present there are over \$2,000,000 invested, and in my opinion the business has but just begun, for apparently there are thousands of square miles of the fish, I think, and the business only wants to be known to be embraced.

54. The manufacturers sell most of their oil in New Bedford, Boston, and New York, and they sometimes export it to Liverpool and Havre.

55. The phosphate manufacturers buy most of it, and what they do not buy is used by the farmers in the pure state. It is considered to be a first-class fertilizer.

56. It is used mostly on leather.

57. Oil fluctuated from 65 cents to 32 cents during the year 1873; for the last five years I should think the average price had been 50 cents per gallon.

58. I do not think that what man does can have any effect in diminishing them, for he has increased his powers of capture for the last few years, and the menhaden have apparently increased in greater proportion than ever before. I explain the increase in this way: The menhaden, from the vast destruction by bluefish, come out at the end of the campaign far below their correct proportions, and when the bluefish ceased to trouble them they began to gain, and are gaining, and *will continue to gain* until they arrive at nature's high-water mark, and then they will stop. Buzzard's Bay, Long Island Sound, Narragansett Bay, and Cape Cod Bay used to be the home of the menhaden, but when the bluefish made those waters his home the menhaden were destroyed or driven away, probably most of them were destroyed, and now that the bluefish are about the same as gone, the menhaden begin to show themselves. This is especially true of Buzzard's and Cape Cod Bays. There have been large quantities of them in New Bedford Harbor for the last two years, and also around the Hen and Chickens.

34. *Statement of E. T. De Blois, Portsmouth, R. I., November 26, 1877.*

We have 3 steamers: E. T. De Blois, 81.30 tons, crew 13; Albert Brown, 78.05 tons, crew 13; Wm. A. Wells, 51.58 tons, crew 13; have caught 26,649 barrels of fish this season; the length of seine 300 fathoms or 1,800 feet; depth, 17 fathoms or 102 feet.

35. *Statement of H. D. Ball, New Shoreham, R. I., January 11, 1875.*

1. Menhaden.

6. They make their first appearance about the 1st of May in large schools.

23. They seem to color the water red.

34. Gill-nets and pounds.

41. No vessels are engaged in the business.

42. For cod bait.

43. None.

58. No.

36. *Statement of Henry W. Clark, keeper of Southeast Light-House, Block Island, R. I., February 6, 1875.*

1. Menhaden.

2. Menhaden are the most abundant.

3. There seem to be as many now as ever; but some seasons they are more plentiful than at others.

4. In 1873 some gangs of fishermen caught 25,000 barrels of them.

5. No; but the first are more wild, and there are more fishermen than there were ten years ago.

6. We first see them about the 1st of May. They come in abundance from the middle of May to the 1st of June. There is generally a May "run" and a June "run."

7. They swim close to the surface of the water.

8. They generally strike in on the coast of Virginia.

9. They come every season.

10. I think nets and seines scare them, and they are not so easily caught as they were before these were used.

11. They generally work in and out with the tide; but when they are making a passage tide does not affect them.

12. The rivers seem to be their favorite resorts.

13. In the summer we find them in shoal water, but in deeper water when cold weather approaches.

14. When the water is cold they swim low.

15. They leave their spawn in the rivers and shoal places.

16. We see schools of young fish about the 1st of September. The fish then are about 2 inches long.

17. They commence to leave about the middle of October, and keep leaving in schools until the middle of November.

18. They follow the coast from Maine to Cape Hatteras.

20. Their principal food is a sort of jelly-fish, I think, for where we find the most of them we find the most fish.

21. In the rivers, in June and July.

23. The spawn is generally found in large clots and appears white.

24. A warm temperature.

25. The spawn is generally found about twenty or thirty feet below the surface.

26. The eggs sink to the bottom, but do not seem to become attached to anything.

28. We see the young fish in September. They are in schools.

30. I never saw anything attached to the fish or in their mouths.

31. Most all larger fish, such as bluefish, sharks, porpoises, &c., are enemies of the menhaden.

32. They always seem healthy.

35. The nets used are about 400 yards long and 90 feet deep. They are made of cotton twine.

36. Sloop yachts are mostly employed; they are from twelve to twenty-five tons burden. There are also eight or ten steamers now in use.

37. From eight to ten.

38. The morning and afternoon are the best times.

39. Slack-water is the best time, because the tide does not tangle the net.

40. The best time to catch fish is while the wind is southeast.

41. There are about one hundred vessels employed, averaging, I think, about nine men for a crew.

42. The fish are boiled and the oil extracted; the refuse is used for manure.

43. There are several factories in Providence River.

45. It depends upon the quantity and fatness of the fish.

46. The machinery costs from ten to fifty thousand dollars.

47. From 40 to 75 cents a barrel.

48. From one to four barrels.

49. In the summer about sixty gallons.

50. One quart.

51. Five gallons.

52. Yes.

54. New York and Boston.

55. All over the country. I think, however, in New England the most is used in the Connecticut Valley for tobacco raising.

56. For tanning.

57. From thirty-five to sixty cents.

58. Yes.

37. *Statement of J. S. Crandall, Watch Hill, R. I., February 20, 1874, and January 1, 1875.*

1. Bony fish.

2. More numerous than any other kind.

3. Diminished.

Captain Wilcox works two fish gangs. He took in 1873 9,800,000; in 1872, 9,450,000; in 1871, 4,500,000. Another factory has three fish gangs and took in 1873 2,500,000.

5. It does.

6. About the 15th of May, and seems to come on to all parts of the coast about one time; the first are the smallest and poorest.

7. Swim high and are seen by color and ripple.

8. They come on to our coast from the southward by the east end of Long Island, and seem to work eastward and westward.

9. There are some seasons not as numerous as others; in '73 they were plentiful; in '74 not so plentiful; in fact their catch was not more than two-thirds as much as in '73.

10. It does; for last season, in the latter parts of the summer and fall, fish were taken outside of Block Island.

11. When the tide runs strong they usually go with the tide.

12. All along the New England coast.

13. No difference, as they are in all depths of water.

14. It does, as they are not as spry in cold water as in warm.

15. They do, but are all of one size.

16. Are seen in great quantities in September, October, and November, from 2 to 6 inches long.

17. November and December, gradually.

18. They work westward when leaving the coast.

20. They live on suction, and their food looks like very fine britt.

21. They spawn in July and August.

28. They are found in great quantities all along the New England coast.

29. They do.

30. The parent fish do not feed on their young.

31. Lampreys and worms are found, but are not very numerous.

32. Man seems to be their worst enemy along our coast, but they have others, as bluefish, sharks, codfish, bass, seal, porpoises, and other fish; but bluefish seem to kill them for sport, as they kill a great many more than they can eat.

33. Never knew of any.

34. Purse-seines mostly.

35. From one hundred to one hundred and fifty fathoms long and eighty to ninety feet deep.

36. Sloops and schooners mostly; some steamers are from twenty to fifty tons burden.

37. From eight to ten compose a gang.

38. All parts of the day.
 39. No difference.
 40. It does not.
 41. About fifty; and will average from eight to ten men each.
 42. They are taken to the try-works at different points along the coast.
 43. Green, Wilcox, Chapman, Allen, and others.
 44. Green's factory in 1873, 35,000 gals.; Captain Wilcox said he took 9,800,000 that averaged 7 gals. to the thousand. Fish have been very fat for a few past years.
 46. Steam-works cost from five to fifty thousand dollars.
 47. About two dollars per thousand.
 50. When they first come on to the coast in the spring they yield the least oil.
 51. In the fall when they are about to leave the coast they yield the greatest quantity of oil.
 53. About the same as right whale oil.
 54. Boston, New York, and Philadelphia.
 55. All through the New England and Middle States it is used for fertilizing.
 56. For tanneries and adulterating paint-oils.
 57. From thirty-eight to forty cents; previous years it has sold as high as sixty-two cents.
 58. It does.
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38. *Statement of William H. Potter, Mystic River, Conn., January 27, 1874.*

1. Bony-fish.
2. More plentiful.
3. Increased.
4. Quin nipiac Oil Company, 2,174 barrels; J. Green & Co., 2,111 barrels; G. S. Allyn & Co., 1,377 barrels; Quiambog Oil Company, 355 barrels; Gardiner Oil Company, 289 barrels; R. Chapman, 200 barrels; total, 6,506 barrels @ \$12.60. In 1872 there were 4,532 barrels.
5. No.
6. April and May. Not generally. Yes.
7. High. Yes. Yes.
8. From the south. Pass out east and west.
9. Not more than two weeks' difference. They fail in port.
10. Probably not, as they have increased in numbers yearly.
11. They come at the turn of the tide.
12. Long Island and Fisher's Island Sounds, Block Island Bay, and Providence River.
13. From three to twenty fathoms.
14. Yes.
15. Yes, but not always.
16. Yes. Three inches in the fall.

17. October 15 to November 15. By degrees.
18. Southerly.
19. South of Hatteras.
20. Vegetable sea-weed and a sort of white jelly which determine their distance from the surface. They follow it.
21. Here in the spring and south in the winter. They spawn in and near rivers.
22. They mix promiscuously.
24. Before and after the warmest weather ; in June, July, and October.
25. At the bottom in river-grass.
26. Float near the bottom.
27. Soon after laid.
28. Yes, in shoals, generally by themselves. Near the shore in the fall.
29. Yes.
30. All larger fish. No.
31. No.
32. Greatly.
33. No.
34. Purse-nets, pounds, and seines.
35. Average, 100 feet deep, 800 to 2,000 feet long.
36. Boats of from 40 to 75 tons burden.
37. Nine.
38. All day and into the night.
39. No great difference.
40. Sometimes.
41. Sixty boats, in all employing 240 men.
42. Used for their oil ; the refuse is used for guano. They are also used for bait. The oil is made at the factories along the coast.
43. See No. 4.
45. Probably twice or thrice the actual catch (see No. 4).
46. Hydraulic presses, tanks, boilers, steam or hand power and running-gear. Costly.
48. One barrel.
49. Forty gallons.
50. A quart to the barrel.
51. Four gallons. In the autumn.
52. Yes.
53. Commenced here on a small scale thirty-five years ago ; it is constantly increasing.
54. New York and Boston.
55. South.
56. Painting and to adulterate other oils.
57. Forty cents per gallon at wholesale. Two years ago it was over 50 cents per gallon.
58. No.

39. *Statement of John Washington, Mystic, Conn., December 30, 1874.*

1. Bony-fish.
2. The most numerous.
3. Not changed.
5. Not late years.
6. The stragglers arrive here about the fore part of April, the schools the last of the month, and continue coming in the first half of the summer.
7. When traveling they swim low; when feeding at the surface they show a ripple. They do not attract birds.
8. They come from the south along the coast; we hear of their passing the Jersey coast eight or ten days sooner than they pass Montauk. After passing in past the outer islands, the large schools separate into smaller ones, and the farther they go from the sea the smaller they get until they arrive at the rivers and coves.
9. Their arrival each year varies but a few days. Never fail. Some seasons not as plenty as others.
10. The large schools do not come as near as formerly.
11. They travel with tides.
12. The entrance of rivers and bays when not disturbed.
13. Any depth suits them, but they swim near the surface.
14. They remain in the warm waters of the rivers and coves through the heat of summer. We also find some stragglers here in the river as late as freezing weather in the fall.
15. We find all ages, from one year up, in the large schools.
16. The young fish of $\frac{3}{4}$ to $1\frac{1}{2}$ inches long are found here passing out of all the rivers and coves which have brackish water in them. In the months of October and November.
17. Old and young begin to go in October, and by the last of November are all gone.
18. They go to southwest along the coast, and faster than they come in the spring.
19. They pass to the south of Cape Hatteras and remain through the winter on the coast and in the sounds and bays of North and South Carolina. This is the winter resort of most kinds of the summer fish of this coast.
20. When in the rivers they feed on fine moss that grows on the weeds, and a scum that floats on the surface. At sea and in the open waters their principal feed are minute jellies and brit, a minute crab that at times is so numerous as to color the water.
21. In the brackish water of all the rivers and coves into which brooks empty their waters. In the months of May, June, and July.
22. My impression is that when the fish start in the spring to migrate north along the coast, those with the ripe spawn (which are earlier with some than others, for we find full-grown spawn all the season) leave the

main school and go to the nearest suitable water and deposit their spawn, anywhere from Carolina to Maine. The fish that come in this river to spawn come in May as stragglers when the schools are outside; at that time the spawn will run and the fish are soon spent; at this time they are worthless for bait or oil, and do not get in good condition until they pass out.

23. No.

24. Forty degrees to sixty degrees.

25. On flats that are nearly dry at low water.

30. Eels and frost-fish gathered in the vicinity of the spawning-grounds.

31. Very free from them.

32. To a great extent, as all other fish feed on them.

33. Have never seen any symptoms of any.

I cannot answer the others as to catch, profits, &c., as I am not engaged in extracting oil from them.

40. *Statement of Leander Wilcox, Mystic Bridge, Conn., January 15, 1875.*

1. Bony fish.

2. Most plentiful.

3. Probably increased.

4. One hundred and nine thousand six hundred barrels. Mint Head Company or Noyes Neck Oil Company, 4,200 barrels; G. S. Allyn & Co., 38,000 barrels; Quinippiac Company, 36,000 barrels; R. Chapman, 9,000 barrels; Quiambog Company, 7,200 barrels; Gardner & Co., 11,200 barrels; Andrews Island Company, 8,000 barrels.

6. May 1. No. At four different times.

7. High. They make a ripple. Yes.

8. South. They pass both east and west in this region.

9. Quite regular. They never fail for more than one season; even then only partially; they return in greater abundance.

11. More are apt to come to the top at the turn of the tide.

12. Differ at different times.

13. From 10 to 100 feet, and they sometimes lie on the bottom.

14. Yes.

15. No. No.

16. Yes, in midsummer. They are from 2 to 3 inches long.

17. In December, or before, in a body or in schools.

18. As they came.

19. In warm climates, always keeping in water of a uniform temperature.

20. A fine white jelly.

21. Here in the spring and south in the winter.

22. There are a dozen or more females to one male.

23. No.
24. The water must be measurably cold, never warm.
25. Shoal.
26. Float.
28. Yes; everywhere; but they do not mix with adults; they school by themselves and are often mistaken for large fish.
29. No.
30. Eels, toad-fish, and other inshore fish.
31. No.
32. Largely from sharks, bluefish, and porpoises.
33. No.
34. Purse-seines, pounds, and gill-nets.
35. From 500 to 1,000 yards long and from 80 to 150 feet deep.
36. Small lighters, from 2 to 75 tons burden, and steamers of the latter size.
37. Ten men.
38. All hours.
39. No. See 11.
40. Not much effect.
41. About 55 altogether. They employ, say, 500 hands, beside 250 landsmen to handle and manufacture into oil.
42. Brought to their factories.
43. Quiambog Oil Company, Mint Head or Noyes Neck Oil Company, G. S. Allyn & Co., R. Chapman & Co., and Quinippiac Company.
44. On an average, one gallon to each barrel of fish. See No. 4.
45. Twice the actual manufacture.
46. Cost from \$5,000 to \$75,000.
47. In 1874 about 35 cents.
48. Differs very much; from 2,500 to 3,000.
53. Commenced twenty years ago.
54. New York and Boston.
55. North and south.
56. To adulterate other oils and for painting and tanning; it takes the place of whale-oil.
57. In 1874, 40 cents.
58. No. See No. 3.

41. *Statement of Samuel C. Beebe, Cornfield Point Light-Vessel, No. 12, Saybrook, Conn., January 6, 1875.*

1. Bony fish.
2. More abundant.
3. Increased.
4. Fish are measured by the thousand in cars. Luce Brothers took in 1873, with three seines, 9,000,000. In 1872, with four seines, 13,000,000. In 1871, 17,000,000.
5. It does not seem to.

6. In April; but these are not the largest. There are two runs, called the spring and eastern run.
7. High. They make ripples on the water.
8. By Watch Hill and Montauk. They work towards the bays and rivers, along the sound and at its head.
9. They have never altogether failed, but are more plentiful at some seasons than at others.
10. No.
11. In bays, &c., they move in at the flow and out at the ebb.
12. Bays.
16. They are, from June to November, at different times. Very small.
17. About the middle of November, in a body.
18. Montauk Point.
19. Southern bays and rivers.
20. Suction of scum, it is supposed.
21. In bays and rivers. During May, June, July, and August.
22. They are mixed indiscriminately.
23. No.
28. They are, in bays, rivers, and creeks.
29. No.
31. No.
32. Very much.
33. No.
34. Mostly purse-nets.
35. From 100 to 150 fathoms long, and 11 to 18 deep.
36. Sloops, mostly averaging 20 tons.
37. From 8 to 12.
38. The greater part.
39. I have never noticed any difference.
40. Not much, but they generally work to windward.
41. About 150 vessels; an average of 10 men each.
42. They are used for the oil.
43. Luce Brothers.
47. In 1873, from \$2 to \$2.50 per thousand. In previous years from \$1.25 to \$2.
48. Eight gallons to the thousand.
50. It is least in summer, and most in the fall.
56. Used for painting.
58. No.

42. *Statement of R. E. Ingham, Saybrook Light-House, Saybrook, Conn.,
March 17, 1874.*

1. Whitefish and bony-fish.
2. More abundant.
3. No.

5. No.

6. First seen in May. Main body arrives in June. First are scattering, and generally largest. There are more runs than one; intervals not regular.

7. Schools swim high, and are always seen. They attract fish-hawks.

9. Their appearance is regular and certain.

10. No.

11. They seem to have no regard to state of tide.

12. In this neighborhood the whole of Long Island Sound and the mouth of Connecticut River, for several miles up.

13. From three inches upward, indefinitely.

14. They are never seen here when the water is cold.

16. Yes, in August. Three to five inches long.

17. In October, mostly in a body.

20. Doubtful; said to be infusoria.

23. No.

28. Yes; in the creeks and coves about the mouth of Connecticut River.

29. No.

30. Enemies not known. Parent fish do not devour them.

31. No.

32. A great extent.

33. No.

34. Purse-nets and pound-nets (pens) and hauling-seines.

35. Purse-nets 100 fathoms and upward long, and 6 to 10 fathoms deep. Pound-nets 100 rods (more or less) long, and as deep as the water where they are used. Seines 60 rods.

36. With purse-nets. Sloops of from 12 to 20 tons. Pound-nets and seines, boats of 2 to 3 tons.

37. Purse-nets and seines, 8 to 10; pound-nets, 3.

38. Any part, as occasion requires.

39. No.

40. No.

41. Between Connecticut River and New Haven, probably 25 vessels and 200 men.

42. Sold for manure, or manufactured into oil and scrap (fish guano). Those for manure are used on the spot; those to be manufactured are sold to neighboring factories.

43. One at Salt Island, Westbrook, owned by John Stokes and others.

47. One dollar and twenty-five cents to \$2 per 1,000 fish; not sold by barrel.

48. One and one-half to 8 gallons to every 1,000 fish, according to size and condition of fish.

54. New York City.

55. Everywhere. It is like wheat flour or greenbacks.

56. Tanning leather and adulterating more expensive oils.

58. No.

43. *Statement of J. L. Stokes, Westbrook, Conn., February 25, 1875.*

1. Whitefish.
 2. Most numerous.
 4. Salt Island Oil Company, 6,400 barrels.
 6. About the middle of May.
 7. Swim low at first.
 8. Around Montauk Point.
 9. Quite regular and certain, though more plenty some years than others.
 11. Come in on the flood tide and go out on ebb tide.
 12. Bays and rivers.
 13. About 15 feet. Swim all depths.
 15. Mature in one year.
 16. Young fish are seen in October, about 6 inches long.
 17. Leave in November in continuous schools.
 18. Around Montauk, bound south.
 19. In a southern climate.
 20. Live on suction; we always find mud inside.
 21. In large bays and sounds.
 28. Yes; they are some seasons abundant.
 30. Eels; parent fish cannot swallow them.
 31. A living species is sometimes found on poor fish, near the gills, and are called by fishermen lousy.
 32. Bluefish destroy more than all other fish. Sharks and porpoises scatter and break the schools.
 35. From 15 to 75 feet deep and from 40 to 100 rods long.
 36. Sloop, steamers, and lighters.
 37. Twelve men to a gang.
 38. All times of the day.
 40. They drift to the leeward in hard winds.
 41. Five vessels; thirty men.
 42. Used by farmers and on the spot for oil.
 43. Salt Island Oil Company; J. L. Stokes, manager.
 46. A hydraulic press costs \$1,000 cash.
 47. Thirty-seven cents per barrel in 1873.
 48. Four gallons to 1,000 fish.
 49. Nine thousand fish make one ton of scrap.
 50. They yield double.
 54. New York and Boston.
 55. At patent manure manufactures.
 56. Used by tanners and rope-makers.
 57. Fifty cents per gallon.
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44. *Statement of F. Lillingston, Stratford, Conn.*

1. Whitefish, generally.
2. One thousand to one.

3. General catch same. Growing scarce on shore previous to, but abundant in 1874.

4. About 5,000 barrels each year.

5. Not appreciably, according to old fishermen.

6. Seen near shore May 20. First largest, August.

7. High. Attract no birds.

8. From the east. During July and August, they came at the first flood, west-northwest to Stratford point; then south-southwest toward Long Island, and returned on ebb tide.

9. Come every year, but do not always strike on shore.

10. No.

11. Old fishermen say none in deep water. My experience is, they always follow the tide.

12. Near fresh water.

14. Yes. Swim high in warm weather.

15. Yes. Sometimes along shore; not usually in deep water.

16. Yes. Three to six inches long.

17. Last of October. At once.

18. South.

21. I have often seen, in a set-net holding 10,000, a roll of spawn 3 feet in circumference, lying on, but not attached to bottom of net; this was in June and July.

26. Sink. No. No.

28. Mouths of rivers.

30. Porpoises, sharks, and bluefish.

33. Many of those we caught on shore had a reddish blotched appearance; sometimes thousands found dead on shore appearing similar. Others were eaten as if by cancer.

34. Greatest catch is by purse-nets.

37. Ten each.

38. All day.

39. No.

40. Yes.

41. Thirty. Three hundred men.

42. Make oil.

43. Geo. W. Miles Company, Welche's Point Company.

44. One thousand to 2,000 barrels.

46. Steam boilers and tanks.

47. Fish sold by 1,000, @ \$1.50 to \$2 per 1,000.

48. Fifty to 100. Much more oily sometimes than others.

49. Twenty to 50 gallons.

52. Yes.

54. New York, Boston, and New Bedford.

55. Principal part goes south.

56. Tanning.

57. Thirty-five cents to \$1.25.

58. No; not appreciably.

45. *Statement of B. Lillingston, Stratford, Conn., February 23, 1874.*

1. Whitefish, bunker, and manhaden.
2. Surpass in numbers all others.
3. Diminished very considerably.
5. Very much.
6. Generally about the 1st of May first seen.
7. Swim on surface; do not attract birds.
8. From east, going west.
9. Found here every season, but in equal abundance.
10. Undoubtedly.
11. Generally follow the tide.
14. Probably, as they are not found here in winter.
16. Immense numbers of young, 2 to 3 inches, long are found in this river (Housatonic) during the fall.
21. In August and September immense numbers strike on and follow up the river; those are invariably poor when so caught. In October the young appear in the river.
28. In and at the mouth of the Housatonic.
30. Bass and bluefish.
33. Large numbers are sometimes washed ashore along this coast in September and October.
34. Pounds, purse-nets, &c.
36. Vessels of light tonnage.
38. Whole day.
39. Flood tide.
40. Does not.
42. Caught for oil; refuse sold for fertilizers.
43. One in Milford Harbor, Miles & Co.
58. Very materially, in this locality.

46. *Statement of George W. Miles, Milford, Conn., January 17, 1874.*

1. Whitefish and menhaden.
2. There are no fish to be compared to them in abundance; they are innumerable.
3. Have not diminished, so far as a person can judge, but have rather increased. We count by the thousand; it takes $3\frac{1}{2}$ barrels for one thousand.
4. 1873, 12,000,000; 1872, 10,000,000; 1871, 8,000,000; 1870, 8,000,000.
5. No, it is not.
6. April and May. Main body arrives in Long Island Sound during June and July. Sometimes the first fish are the largest; have known small fish to come in as late as August. The schools or runs appear to come at intervals of from two to three weeks.
7. The fish swim both high and low, and can only be captured to any

extent when seen on the surface of the water; they can be seen for miles in every direction lying on or near the surface, and are discovered by the ripple on the water; also by birds, sea-gulls being attracted by them.

8. We first hear of them along the sea-coast of New Jersey and Long Island; they come into the sound by way of Montauk. The early fish follow along the Connecticut shores and up the rivers, but later in the season, when the waters are warm, they are found off shore in deep water. Occasionally they work in shore and up the rivers.

9. Their appearance is regular and certain; have never known them to fail.

10. No; but they are more difficult to capture.

11. Not noticeable.

12. Long Island Sound, during the summer months, appears to be one of their favorite localities.

13. Early in the season they prefer shoal water, and they swim low, but during the summer and fall they prefer deep water and swim high.

14. In warm weather they appear to be in thin schools and are scattered more on the surface.

15. Yes. The one and two year old fish are often found with the oldest.

16. The young fish are seen during the months of August and September, from 3 to 4 inches in length.

17. They begin to leave the sound about the 1st of September, and leave by degrees in large bodies. They are all gone by the 1st or 15th of October.

18. Same route as they come by.

19. South or near the Gulf stream.

20. Scum, or minute insect, on the surface.

21. Along the shores and rivers in May and June.

22. Sexes are mixed indiscriminately.

26. They sink to the bottom.

28. The young are found in great abundance all along the shores of the sound, "and more particularly in the vicinity of the oil factories," in large schools. I have seen hundreds of schools at a time, containing millions in a body. In fact, the expert fishermen sometimes mistake them for large fish, and make preparations to set their net before they find their mistake.

29. Seldom, if ever; occasionally we see fish that have spawns in them; it shows after being cooked; the very large ocean fish that never come into the sound but come in from sea and are captured east of New London at Montauk, south side of Long Island, Sandy Hook, and the Jersey coast; from these more particularly the spawn is found to run.

31. Occasionally lampreys. We sometimes notice red lice late in the fall on the large fish that come in from sea.

32. Sharks are their greatest enemy; these and porpoises prey upon them continually and destroy large numbers of them.

33. Never have seen any that have died from sickness or disease.
34. The nets are made of cotton twine, and purse up at the bottom.
35. Nets are from 120 to 140 fathoms long, and from 10 to 15 fathoms deep, according to the depth of water where they are used.
36. Fast sailing sloops and sloop-yachts, of from 20 to 25 tons burden, for the men who find and capture the fish, and sloops (lighters) of from 15 to 30 tons burden to carry the fish away. On the coast of Maine steamers are used in place of the yachts and lighters.
37. Eleven men and two boys to each net. The boys assist on the lighters.
38. All day, from daylight to dark.
39. The tide makes no difference with them.
40. Sometimes it does; usually they are moving to the windward when on the surface.
41. We have 12 sloops, and 50 men employed on them; also from 15 to 25 men employed in each factory. If the fish come in plentifully, we increase our working forces.
42. The fish are taken directly after being caught to the factory, and placed immediately in large tanks, and boiled by steam until thoroughly cooked and the flesh will separate from the bones when taken out of the water. Some are made into sardines, which are pronounced the best in the market.
43. The George W. Miles Company have the two largest factories; these are in Connecticut or New York State. One is a floating factory, and is moved to the locality where the fish are most plentiful: the Welche's Point Oil Company, with one net and three sloops; Fowler and Colburn, of Guilford, two nets and 6 sloops.
44. The largest quantity of oil we ever made at one factory in any one year was in 1871; we then made 100,000 gallons in about 50 working days. The largest quantity in the shortest time was 21,000 gallons of oil in 72 hours, or 7,000 gallons per day of 24 hours. This unusual quantity of oil was owing to the fatness of the fish. We made in 1872 60,000 gallons of oil; in 1873, 105,000 gallons at the two factories, one factory not being in operation the whole season on account of the delay caused by lawsuits brought by some malicious and designing persons for purposes of gain. A part of the season was thus lost, and the quantity of oil was less than what it should be.
45. The capacity for oil is limited by the facilities for capturing the fish; the nets and vessels engaged must be the best, and the men with large experience are required to make the business successful.
46. Boilers cost from \$2,000 to \$4,000; two hydraulic presses, with curbs and fixtures, cost \$2,000 each; engines, pumps, shafting, pulleys, &c., range from \$10,000 to \$50,000.
47. In 1873 the price for fish ranged from \$1 to \$2.50 per thousand, according to the yield of oil.
48. We have worked fish when they would not make over one gallon

per thousand and from that all the way to 18 gallons. The average yield is from 4 to 6 gallons per thousand. Some seasons the fish are so poor we can barely pay expenses. We then are obliged to pay low prices for fish—say from \$1.25 to \$1.50 per thousand. The fishermen at those prices cannot make day wages unless the fish are very plenty. The consequence is, when the fish are scarce the men leave the business, and the vessels have to lay up until other men can be found. This is one great drawback to the business, and many factories have been obliged to give up the business on account of it.

49. This all depends on the quality of the fish, whether fat or poor, and will vary from 10 to 150 gallons, and in some rare cases as high as 250 gallons to one ton.

50. This all depends on the quality of the fish. Some days a net will take fish that will make 15 gallons, and perhaps the next haul the fish taken might not make 5 gallons; but these extremes are rare, except late in the fall, when the fish are moving south and come together from different localities; then we are as liable to get poor fish as fat ones.

51. In this vicinity, during July, August, and September, we get the fish only that come into the sound for their feeding-ground, and which fat after they get here. If they are poor, we have the largest catch in June and July. If they are increasing in fatness or yield of oil, we cannot capture them successfully until August and September. The fat fish in the sound are usually wild and hard to take until late; this may be owing somewhat to the fact that the feed is plentiful and low in the water. When we have an unusual dry season, so very dry that cress are almost a failure, then we are pretty sure of fat fish and an unusual quantity of jelly-fish floating on the water, which perhaps may be one source of supply of feed. On the other hand, in very wet seasons we find them below the average in yield of oil.

52. The northern fish always yield more than the southern. The fish appear here and farther north nine seasons out of ten "spring poor," as the farmer terms his cattle that have been exposed to the inclement weather and fed on coarse fodder; but after they get here, if their feed is plenty, they fatten very fast. This can be proved by the past season. During the months of May and June one million of fish would make only eight hundred gallons of oil; in August, the yield was from eight to ten gallons per thousand, and in September ten to twelve gallons per thousand.

54. The market for oil is principally in New York and Boston. The dealers in those cities have a very extensive trade all over this country, and large quantities are shipped to Europe.

55. The scrap is used very extensively in a raw state by the farmers and tobacco-growers of Connecticut, Rhode Island, Massachusetts, Long Island, and New York State. It is a standard manure and fertilizer when used judiciously by those who understand how to use it. The principal market is with the superphosphate manufacturers. When

manufactured it is in a much better condition for use, and can be applied more evenly to the land and in much smaller quantities to the crops without danger of burning. This is the greatest source of supply this country affords for a manure rich in ammonia, and it is worth more to this country than the islands that furnish us with Peruvian guano. In the season of 1873 there were landed in the cities of Charleston, S. C., and Savannah, Ga., alone 85,000 tons of superphosphate, nearly all of it having fish-scrap as its base.

56. The oil is used mostly by tanners and curriers; it is also used for outside painting.

57. Prices ranged in 1873 from 60 cents in April to 40 cents in August; then to 46 and 48 cents in September; then the panic burst upon the country and brought business to a stand-still. Prices for a few past years have ranged from 45 to 60 cents.

58. It is not possible nor in the power of man, with all the modern improvements at his command, to materially diminish their numbers.

On the shores of Connecticut 88,200,000 fish, producing 8,820 tons of scrap, valued at \$16 per ton in bulk at the factory, were caught, and 309,900 gallons of oil were made, bringing 45 cents per gallon. On the shores of Long Island 82,700,000 fish, producing 8,270 tons scrap, at \$16 per ton, were caught, and 291,200 gallons of oil were made, bringing 45 cents per gallon.

The above is a correct statement, as near as possible, of all the fish caught on the shores of Connecticut and Long Island during the season of 1872. Comparison with the previous year shows a decrease in the catch of fish of some 70,000,000, which would make, at the average yield of oil this year, 245,000 gallons, and about 7,000 tons of scrap. The decrease in the catch is readily explained: there were some six or eight manufacturers less than in 1871, some having stopped business on account of threats of lawsuits by malicious persons, who attempted to break up every honorable and profitable business.

Notwithstanding the decrease in catch of fish there were more seen in the waters, and those who persisted in catching from the beginning to the end of the season caught more than they did the previous year; in fact, fish were never more plentiful. It would seem, from the great quantity caught from year to year, that whitefish would soon be extinct; but it is a surprising fact that for the past few years they have been steadily increasing in numbers.

47. *Statement of W. S. Havens, Collector of Customs, Sag Harbor, N. Y.,
January 1, 1875.*

1. Menhaden.
2. More than all other kinds together.
3. No apparent change.
5. Not perceptibly.

6. April; come in schools; largest in the fall.
7. Generally near the surface.
8. Come and go, south.
9. Some years they are a partial failure, but I do not know the cause.
10. Yes.
11. None perceptible.
12. In this district; Gardiner's Bay.
13. Swim near the surface.
14. Yes, they leave soon after cold weather.
15. Generally find them of the same size.
17. Leave in a body.
18. For the south.
20. On a mossy substance called bunker-feed.
21. In creeks, inlets, and rivers.
22. All go together.
23. Not discovered.
24. Moderately warm.
25. Various depths.
26. Think they settle to the bottom.
28. Rarely seen at all.
29. Believe not.
30. Sharks and bluefish devour them.
31. They are not found there.
32. To a great extent.
34. Purse-nets.
35. Length, 150 fathoms; depth, 100 feet.
36. Sloops, and schooners of from 15 to 20 tons burden.
37. Nine men.
38. About three-fourths of the day.
39. No.
40. East winds break them up.
41. Sixty vessels and 540 men.
42. Used near by.
43. About 20. Wells, Parsons, Vail, Tuthill, and others.
44. Five hundred barrels to each factory.
45. From 1,000 to 1,500 barrels.
46. Steam and try-pots; from \$5,000 to \$10,000.
47. Say 30 cents.
48. 200 fish.
49. Some more, and some less.
50. One quart.
51. Four gallons to one barrel.
53. Say twenty years.
54. New York.
55. Southern States.
56. Painting and adulterating.

57. Fifty cents to \$1.

58. No; if it does we do not notice it.

48. *Statement of J. Morrison Raynor, Agent for Sterling Company, Greenport, December 20, 1877.*

The number of gears and sail employed by us the past season was three, consisting of three yachts, six lighters or carry-away boats. The Swan, 24.64 tons; the Mary H. Sisson, 20.95 tons; the Dauntless, 19.70 tons; Titus, Bunker City, 8.64 tons; Rough and Ready, 10.24 tons; sloop Sarah, 10.39 tons; sloop Kate Romer, 9.83 tons; sloop Friendly, 13.37 tons; sloop John Marcy, 12.50 tons. Each gang consists of 8 men, 2 boys, 1 cook—making 9 men and 2 boys; total, 27 men and 8 boys. The men fish for a share and not for wages, except cook and boys hired by them. Use purse-seines; are about 125 to 150 fathoms long, 80 to 100 feet deep. The number of fish taken by them was 14,449,000.

49. *Statement of Hawkins Brothers, Jamesport, N. Y., February 25, 1875.*

1. Mossbunker or menhaden.
2. Much more numerous.
3. Cannot perceive any difference.
5. Cannot perceive that it does.
6. About the 1st of May, on the coast of Long Island. The first are usually the largest. The schools come in at intervals from the 1st of May to the last of August.
7. They swim both high and low, but usually the former, and make a ripple on the water, attracting fish-hawks only.
8. Come from the south, following the coast and stopping in the bays and sounds.
9. They are not regular but are certain, and are more plentiful in some localities and at some seasons than others.
10. From experience we think not.
11. Think they move toward the shore more on the flood than on the ebb tide.
12. In bays, sounds, and their entrances.
13. In all depths on the coast and in the bays.
14. It does.
15. Think not; we find no small fish in the spring of the year. I believe these fish get their growth in one year.
16. Yes; from July to November, from one to six inches long.
17. Commence to leave in October by degrees.
18. Following the coast south.
21. In heads of bays in the spring.

28. In great abundance in the heads of bays when first spawned, gradually dropping out into deeper water as they attain size.

29. I think not.

30. Don't know of any; think not.

31. Nothing but an insect, which the fishermen call lice, is occasionally found on the outside of fish, eating into the body.

32. To a very great extent, especially bluefish.

33. Never have known any.

34. Set-nets, pounds, haul-nets, and purse-nets.

35. Haul-nets are from $\frac{1}{2}$ to 1 mile long, depth according to depth of water where the fishing is done; purse-nets are from 600 to 1,000 feet long, and from 70 to 90 feet deep.

36. For purse-nets, sloops, schooners, and steamers, of from 10 to 50 tons burden.

37. To man a purse-net, 11 men.

38. All parts.

39. Think more on the flood tide.

40. It does.

41. Number of vessels, 191; whole number of men, 715. This includes purse-nets only.

42. Sometimes they are used in the raw state for manure, but are principally carried to the factories, where they are manufactured into oil and scrap.

43. On Barren Island, Jones & Co., V. Koon, Goodkind Bros., Hawkins Bros.; on shores of Gardiner's Bay, D. Wells & Sons, Sterling Oil Company, Horton & Co., Green & Co., Jonathan Preston & Co., Cartwright & Co., Frank Price & Co.

44. About 25,000 gallons.

45. According to the fatness of the fish; say, 30,000 gallons.

46. Engines, boilers, steam-pumps, hydraulic power, and piping, from \$15,000 to \$25,000.

47. 1873, Barren Island, 50 cents; Gardiner's Bay, 60 cents.

48. Barren Island, $\frac{1}{2}$ barrel; Gardiner's Bay, $\frac{1}{3}$ of barrel.

49. Barren Island, 57 gallons; Gardiner's Bay, 85 gallons.

50. One gallon; in midsummer.

51. Four and one-half gallons in October and November.

52. Northern fish yield most oil.

53. The manufacture of oil was commenced on the shores of Gardiner's Bay about 1850, when the oil was extracted by fermentation.

54. New York, Boston, and New Bedford.

55. New York, Connecticut, New Jersey, Maryland, and Virginia.

56. Painting, tanning, rope-making, and soap-making.

57. Forty-five cents per gallon; previous years from 45 cents to \$1 per gallon.

58. It does not.

50. *Statement of Benjamin H. Sisson, Greenport, R. I., January 29, 1874.*

1. Moss-bunkers.
2. They are most numerous.
3. No apparent difference.
4. In 1873, 50,000,000; 10,000,000 additional for shore fisheries.
5. No.
6. In March and April. On the 1st of May. The first are the largest. There are different runs coming in, and at intervals of six weeks.
7. The first run are known by their capture; all others by sight and by birds.
8. From the south.
9. The fish never fail, but some years they are scarce.
10. Yes.
11. In certain localities a flood tide is considered the most favorable for a catch.
12. Shoal-water.
13. From 10 to 12 feet.
14. Yes.
15. Yes. Sometimes they are mixed.
16. Yes. From July to November. From 1 to 6 inches long.
17. From September to January. By degrees.
18. Ocean routes.
19. I hear nothing from them south of Cape Hatteras.
20. Marine animalculæ, with small strong fiber.
21. There seems to be much difference of opinion about this among the fishermen; my own impression is that of the first that come in the spring, the old fish go stealthily into all the shoal and water bays, deposit their spawn and milt, then go out again and join the general migration east. These spawn hatch by the last of June or first of July, as the small fish are first seen in these localities about this time. No doubt there is another spawning time in the fall, outside, in deep water.
22. They are mixed indiscriminately.
23. Yes, in deep water.
24. Cool water.
25. Near the surface.
26. I think they float.
27. In June and July. From one month to six weeks.
28. Everywhere in abundance.
29. Not unless handled roughly.
30. Eels and bluefish. No.
31. Worms, crabs, and lampreys are found on the outside, but not within.
32. Very much. I have seen 100 moss-bunkers taken from one shark.
33. We have not noticed any in this district.
34. Purse-nets, gill-nets, seines, and pounds.
35. Purse-nets are from 900 to 1,000 feet long and 100 feet deep Gill-

nets are smaller; from 60 to 500 feet long, by 10 feet deep. Shore seines are from $\frac{1}{2}$ to $\frac{3}{4}$ of a mile long and from 20 to 30 feet deep.

36. Steamers, schooners, sloops, and cat-rigged boats, from 5 to 50 tons.

37. Nine.

38. All day.

39. This depends on the locality.

40. They often leave during high winds.

41. One hundred and five vessels and 400 men.

42. It is principally turned to oil and guano.

43. D. D. Wells & Sons, Sterling County; Hawkins Brothers; H. Corwin & Co.; G. P. Horton & Co.; Vail & Benjamin; Benjamin Bay Payn; Green & Co.; B. C. Cartwright; Floating fish-factory "Falcon," of 2,500 tons, Capt. George Tuthill; Floating fish-factory "Ranger," of 1,500 tons, Capt. Frank Price.

44. From 10,000 to 60,000 gallons.

45. From 1,000,000 to 2,000,000 per week.

46. Boilers and engines, costing from ten to twenty thousand dollars each.

48. Some fish will make half a gallon per thousand; some 22 gallons.

49. Eight thousand fish will make one ton of green scrap.

50. One gallon per thousand in the spring and fall.

51. Twenty-two gallons per thousand. In September and October.

52. Yes.

53. The moss-bunker business previous to 1850 had been carried on for a long time—certainly as far back as 1800. The seines used were very long, and were handled from the shore. They frequently caught 1,000,000 fish at a haul. These fish were used by farmers in a raw state for top-dressing. Some portion of them were buried, however, and used as a compost. In the year 1850, D. D. Wells & Son started the first factory in this vicinity, using steam for making oil and scrap. At the same time there were other parties using a few pots (whalers' try pots), boiling the fish in water and making a very indifferent oil and scrap; these, however, were not successful, and were soon abandoned. The first oil made by D. D. Wells & Son was of a very dark color, and contained much fleshy matter, which made it very offensive to the smell. It did not come into much use for some time, and for a long time the profits were small; but by persistent effort on their part, in perfecting machinery, the quality of the oil was so much improved as to come into general use for certain purposes: for painting, tanning, in the manufacture of rope, and for the adulteration of other oils; the scrap was also very much improved by drying, grinding, pulverizing, &c.; thus the business continued so prosperously that during the war the business had come to be quite remunerative. At that time, under the impulse of high prices and plenty of money, quite a number of factories were put up, and for two or three years the business was some-

what overdone. Since that time many have gone out of the business altogether; others have consolidated, and at the present writing there are ten establishments in operation and are doing a fair business, giving employment to a large number of people and bringing up a hardy race of boatmen and sailors. There is about \$500,000 invested in the business in this vicinity.

54. New York, Boston, and Europe.

55. The Connecticut Valley and the Southern States.

56. For painting, tanning, manufacture of rope, lubricating, and adulteration.

57. Thirty-two to 47 cents per gallon in 1873; 40 to 50 cents per gallon in previous years.

58. The general opinion is that there is no diminution.

51. *Statement of David G. Vail, River Head, Long Island, March 20, 1875.*

1. Menhaden.

2. More abundant than any other.

3. Has not diminished.

4. Fifty millions of fish in 1873, and as many in 1874; in this vicinity we measure them and pay for them by the thousand, calling each fish 21 inches, or taking up that amount of space. When they are fat they are larger, and then by measure we would get perhaps only 800 fish for 1,000; then sometimes they come small, and poor, and we would get, perhaps, 1,200 fish for the 1,000. In Maine they measure them in barrels, calling 300 fish to each barrel.

5. Not any, judging from my experience for the last ten years.

6. From the 1st to the 10th of May.

7. They swim low when they first come, if the weather is cool, but soon come to the top of the water, and are known as top-water fish.

8. They come from the south, following the coast generally.

9. Their appearance is regular and certain; I never knew them to fail; but they are sometimes more plentiful on some grounds than on others.

10. I think it does tend to change their ground.

11. Generally they go with the tide.

12. Bays and sounds.

13. We find them in any depth of water, but generally they swim on the top of the water.

14. They like warm temperature.

15. We find one and two year old fish all mixed together.

16. Yes; they are spawned at the head of the bays, and stay all summer, until they are half grown.

17. They leave about the 1st of November, generally in a body.

18. By the same route as they came, following the coast south.

19. Somewhere south.
20. Kind of very fine jelly fish ; they suck their food, for they have no teeth.
21. At the head of bays generally, at all times of the season.
22. I think they are indiscriminately mixed as to male and female.
23. No.
24. Warm temperature.
25. Near the bottom.
26. They float in the water until hatched.
28. Are in abundance in the locality where they are hatched.
29. Yes, when nearly matured.
30. All kinds of fish destroy them, except the parent.
31. No.
32. They do not suffer any when compared with the quantities of them.
33. No.
34. Purse-nets.
35. From 600 to 1,200 feet long, and 80 feet deep.
36. Steamers, sloops, and schooners, from 10 to 100 tons each.
37. About 12 men to each net, with 3 boats or sloops.
38. All day, unless they load their boats sooner.
39. No.
40. Do not think it does.
41. Fifty vessels, and 175 men.
42. They are sent directly to the factories by the boats that follow the net for that purpose. They are sometimes used as food, and are very sweet, but bony.
43. There are 10, owned by George F. Tuthill & Co., F. Price & Co., D. Wells & Son., J. Preston & Co., Vail, Benjamin & Co., Hawkins Bros., H. P. Green, B. C. Cartwright & Co., G. H. Payne, and Fithian & Horton.
44. Six hundred barrels of 40 gallons each.
45. They could manufacture large quantities if they could get the fish and have them fat.
46. Boiler and engine, hydraulic presses, large tanks for cooking and packing cost from \$10,000 to \$50,000.
47. From \$1 to \$2 per barrel ; say \$1.50 for the season.
48. Two hundred fish are about an average for the season.
49. Depends on fatness of fish ; it takes from 8,000 to 10,000 fish to make 1 ton of scrap.
50. Sometimes when very poor we cannot get over $\frac{1}{2}$ gallon of oil, that is in the spring and summer.
51. When very fat 6 gallons can be taken from 1 barrel.
52. Yes.
53. The manufacture of oil from menhaden was started in this vicinity about thirty years ago by Daniel D. Wells, who boiled them in large

kettles and skimmed the oil from the kettle ; then there was only about one-half of the oil saved. Since then the business has increased until now an enormous business is carried on.

54. New York.

55. Phosphated for the Southern States.

56. Used as a lubricating oil and by leather manufacturers; also for paint.

57. Price in 1873 was about 45 cents a gallon; from 75 cents to \$1.10 in previous years.

58. No ; not by any mode that has been practiced.

52. *Statement of Joseph Whaley, Point Judith Light, Point Judith, R. I.,
December 28, 1874.*

MR. BAIRD :

SIR : I have received a circular in regard to the fish known in this vicinity as menhaden. I will answer all questions I can. I did not receive any blank, so I put it on this.

1. Menhaden.
2. More plentiful than any other kind.
3. I think I saw more pass here last June than any time since 1862.
4. Five hundred barrels.
5. I do not think that it does, as they are as plenty now as ten years ago.
6. The first fish are seen about the 20th of May ; the main body get along about the middle of June. They pass here to the east from the 20th of May to the 1st of July.
7. They, as a general thing, near the top of the water, and make a ripple or a slick. They do not attract birds, as they do not drive up any small bait or other fish.
8. From the south and bound north and east.
9. Very regular sometimes ; if the weather is cold and easterly winds prevail it puts them back ten to fifteen days.
10. I do not think it does.
11. They go or move with the tide, or the way the tide is setting.
12. Rivers and bays.
13. Sometimes high, and sometimes about half way to the bottom. I think they prefer water from 10 to 20 feet deep.
14. They leave here when the water gets too cold.
15. I do not think they do. I cannot tell the young from the old, as they get their growth in a year. I have seen them shut up for nine months ; they have then nearly their length.
16. They are seen in large quantities in November ; they are about 2 inches long.
17. They begin to leave in October, and continue to the 15th of December by degrees.

18. Southwest.
19. Some place where the water is warmer than it is here.
21. In rivers and bays.
28. They are, in river and bay, and all along shore.
29. Yes; they suffer most from bluefish and striped bass when they are young. I do not know to what extent.
34. Purse-seines and gill-nets.
35. The length varies from 200 to 300 yards; the depth from 20 to 60 feet.
36. Sail and steamers.
58. I do not think that it does.

I will here state that there is a great many fish taken near this point, but as there is no harbor near they are carried away to market. This is a passing point for most all kinds of fish to pass from the south to the north, from the east to the west.

53. *Statement of A. G. Wolf, Absecon Light, Atlantic City, N. J., March 6, 1874.*

1. Mossbunker.
2. More numerous than any other fish.
3. No difference.
4. Two hundred and fifteen barrels by Adams & Co. About same last year.
5. No.
6. In April; main body in July. No. Yes. Depending on tide.
7. Very high; fins out of water; come in a solid body, as deep as you can see in the water. They make a ripple and can be seen on calm days for half a mile. Attract birds, such as fish-hawks and sea-gulls.
8. Come from the south; shift into and out of inlets with the tide.
9. Have never failed to come in regularly.
10. Has no effect.
11. Drift with the tide.
12. No favorite feeding grounds.
13. Swim high, and are seen in both shoal and deep water.
14. No.
15. Come in all sizes; cannot tell their age.
16. In the fall you can see millions of little fish not over two inches long.
17. Leave by degrees, beginning in September.
18. Go south.
19. South.
20. Can't tell; they take no bait.
21. Up in the bays and inlets in spring.
24. Seem to prefer warm water, for they go up the bays as far as possible.

26. Settle and become attached to shells and stones.
28. Yes ; in fresh-water creeks.
29. Yes.
30. Bluefish catch the fish. Parents do not eat the spawn.
31. Bug or fish-louse on outside ; a worm is attached to the outside and bores into them, and sometimes a bug is found in the roof of the mouth.
32. Suffer from all fish ; bluefish are their worst enemy.
33. Not here.
34. Gill and purse nets.
35. One hundred to three hundred fathoms long, 12 feet deep.
36. Boats from four to five tons for gill-nets ; schooners, sloops, and one steamer of from ten to twenty tons for purse-nets.
37. Eleven men to a net.
38. All day, if good weather.
39. No.
40. East wind affects them.
41. Ten vessels ; forty men.
42. Tried out near Little and Great Egg Harbors.
43. None in the neighborhood.
44. Two hundred and fifteen barrels.
45. Not known.
46. Five thousand dollars in one factory.
47. One dollar and twenty-five cents per thousand fish.
48. Four gallons of oil per thousand fish.
49. Forty gallons.
50. Least in August.
51. Greatest in November, eleven gallons per thousand.
52. Northern fish yield most.
54. New York City.
55. The South.
56. For tanning and adulterating paint-oils.
57. Forty-five cents per gallon.
58. Does not seem to diminish them.

Questions were answered by Messrs. Bowen, Strickland, and Conover, of Atlantic City, and Capt. John D. Sanders, of Leedsville, N. J.

54. *Statement of Albert Morris, Somers Point, N. J., January 12, 1875.*

1. Mossbunker.
2. There are a thousand times as many.
3. No.
4. 7,200 ; 1874, 12,000.
5. Think not.
6. About 1st of May. The main body arrive about 20th June. There are sometimes three or four runs a week.

7. High, so that they can be seen.
8. Mostly follow the coast.
9. It always has been regular.
10. It does not, for sometimes they are caught in 2 feet of water.
11. Go with the tide.
12. From the beach to about five or six miles from shore, and sometimes more.
13. From 1 to 10 fathoms.
14. It does.
15. They do both.
16. They are in great abundance, and are from 3 to 5 inches in length.
17. About the middle of September, but the eastern run comes along about the last of October.
18. They follow the coast.
19. From Chesapeake Bay to Cape Hatteras.
20. A very small substance, scarcely seen by the naked eye when the sun shines.
21. Along the coast.
28. They are, along the coast.
29. They are.
31. Crabs are found in the gills.
32. To quite an extent.
33. Yes; in October, 1873, they floated ashore by tons.
34. Purse-nets.
35. Two hundred fathoms long, 500 meshes deep.
36. Sloops of about 20 tons.
37. Seven.
38. All day.
39. Most of our fishing is done out at sea, where the tide does not make any difference.
40. It does, especially easterly winds.
41. Three vessels; 9 men.
42. For manure (guano); part is used in the vicinity, and part shipped to Wilmington and Philadelphia.
43. Somers Point Oil Works, John D. Sanders, J. S. Adams, and others.
44. About 300 barrels.
45. Two thousand barrels.
46. Pot work. Costs \$8,000.
47. Thirty-one cents per barrel.
48. One barrel.
49. Forty-five gallons.
50. One quart; in the summer, July and August.
51. Four gallons, in October and November.
52. They do.
54. New York.

55. Wilmington.
 56. Painting.
 57. Forty to 50 cents per gallon.
 58. I think not.
-

55. *Statement of D. E. Foster, Cape May Light-House, N. J., February 15, 1875.*

1. Bony fish.
 2. They are more numerous than any other fish visiting our coast.
 6. They come from the south; the first arrival is about April; these fish are larger but not so fat as those which come about July.
 7. They generally swim in schools near the surface.
 17. They leave about November, heading to the north.
 30. They are preyed upon by sharks, porpoises, fish-hawks, &c.
 33. I have not known of any disease to prevail among the fish here.
 42. They are used mostly for manure. There is no oil manufactured here.
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56. *Statement of A. A. Owens, Philadelphia, Pa., March 31, 1875.*

1. Oldwives and mossbunkers.
3. Cannot perceive either way.
4. None.
5. No; there are very few captured.
6. They are first seen in June and July. The last are the largest.
7. They swim high and make a ripple.
8. From the northeast in large schools.
9. They seldom fail.
10. I think not.
11. They come in on the flood and pass out on the ebb tide.
12. Along the coast and in the inlets.
13. They generally prefer deep water.
14. They become somewhat torpid when sudden cold weather comes.
15. Sometimes both together.
16. There are no very small ones seen.
17. They leave by degrees in the fall.
18. Northward and eastward.
22. They seem to mix indiscriminately in schools.
29. I think not.
30. The bluefish is their greatest enemy.
32. They are destroyed in great numbers by fish on the coast.
33. Very seldom in this vicinity.
34. Pocket nets and seines.
43. None.
51. Greatest in the fall.
54. New York and Philadelphia.

55. New York and Philadelphia.

57. Fifty cents per gallon.

58. We cannot see that it does diminish them.

57. *Statement of James H. Bell, Mispillion River, Delaware Bay, January 23, 1875.*

1. Oldwife, a corruption of alewife, is the name universally applied to the fish in this vicinity, and all along the western shore of Delaware Bay.

2. They rank equal to if not more abundant than the sea trout, and far exceed the number of any other fish; a thousand bushels of trout are sometimes taken at a haul; but the main fishing season does not last over a month, while menhaden are caught more or less during six months of the year.

3. No diminution is noticeable; the number seems to be about the same one year with another.

4. These fish are not sought in this vicinity for any purpose whatever; and when caught in seines laid for other fish by fishermen, are left on the beach to rot, or taken home and fed directly to hogs, or composted for fertilizing the soil, for which they are only valuable.

5. Quantity taken from the water never seems to affect the supply.

6. They are first seen here early in March, and continue to increase in number till about the 15th April, when the sea-trout frightens them off. They soon return in increasing numbers, however, till the middle or last of May, after which they begin to disappear in large schools until about the 1st August, when they again appear numerous, and continue so, if the weather is mild, until the latter part of September, when they begin to disappear.

7. High; by their capture at first, windy weather generally prevailing in March, renders the bay too rough for the ripple to be seen; besides, they are not inclined to show themselves about the surface till the water becomes warm, as in August and September; the fish-hawk and trout-gull follow closely in their wake, and destroy a great many.

8. The opinion prevails, that after entering the bay they follow the main channel, spreading toward the shore on either side as they advance, until arrested by brackish water. The western shore of this bay is very shallow, the tide near the beach seldom rising above six or seven feet. When the tide is three-quarters flood, the fish run in close to land, and are caught within twenty yards of the beach; as none are seen on the surface at such times, it is probable that they are then in pursuit of food; at slack-water to first quarter ebb, if it is calm, the water is spotted with the break or ripple; and as the tide recedes they float out with it to deep water.

9. Their appearance is as regular as the shad; an old fisherman remarked to me that he never knew it to fail, or a diminution in their

abundance for a single season; hence, no cause is assignable for a decrease when none is known.

10. No gill or haul seines frighten them if they are out of sight; but when sunning on the surface, any noise close by sends the school out of sight in an instant, to reappear not far off; if the object was to catch them, this is the most favorable time, and the purse-net is most likely to accomplish it.

11. In-shore on the young flood to feed, and out to deep water again when the ebb is not lower than four feet.

12. Sandy bottom predominates on this coast, and there is where most fish are found, although they are caught in numbers where the bottom is muddy. Some few fish are found considerable distances up the creeks at high water.

13. Most fish are found in 10 to 15 feet of water, or deeper; they are also caught in large numbers in water as shallow as 6 feet; sometimes when it is not deeper than 4 feet.

14. Not known, but am inclined to think they prefer warm water until arriving at full size.

15. Medium and small fish are found together, not probably in the same schools, but close enough together for the seine to catch fish ranging in size from 9 inches down to 3 inches.

16. Yes; immense quantities of them from about the 10th September to 1st October, in size from 3 inches up, and smaller ones, probably, but I have not seen any.

17. Toward the latter part of September they gradually disappear.

18. Run out to the main bay-channel; beyond that I have no knowledge.

19. It is impossible for me to say with certainty, but I think near the Gulf Stream in the Atlantic Ocean, from the fact that this fish appears so partial to warm water.

20. I have not the least doubt that their food is something similar to that of shad, such as minute animalcula found in muddy bottoms; their digestion is evidently very rapid, as the contents of the stomach bear a nearer resemblance to black mud than to anything else.

21. But for what took place about the 7th of last November on this coast I should hesitate to give any opinion in reply to this query. After the last menhaden had disappeared from these waters, and as late as the 7th November, all at once from Cape May to Cape Henlopen, and up the bay 18 miles, to and above this station, the water was crowded with the largest size of this fish ever seen by any person on the coast, the largest being quite as big as medium-sized shad, extremely fat, and full three-fourths of them pregnant with large and nearly matured roe; the shores of the bay from Lewes up this far were lined with dead fish, bitten to death by bluefish. Some of the latter weighed 25 pounds. Numbers of dead fish were without tails, and all were more or less mutilated by the teeth of the bluefish, or snapping mackerel as it is called at Cape May.

Whether they were exterminated by their enemy or driven back to the ocean is not known, but not one of them could be caught on the coast sixty hours after their arrival, and none have been seen since; nor were they ever known here before so late in the season, or of such large size, or containing the fully-developed roe, or, in fact, any roe at all. Such fish are entirely new to these waters. I am of the opinion that the ocean is their spawning element, and being attacked while spawning by immense numbers of very large bluefish, they flee before it till reaching shallow water, then, if all were not killed, turn and escape to sea. These fish were remarkable for uniformity in size, being over a foot long and about one inch and a quarter thick through the back. A gentleman remarked to me that he thought none of us had ever seen any full-grown "oldwives" before. Ordinarily this fish is not marketable, but so anxious were the people after these large ones that \$14 per barrel was offered for them salt. It seems to me that if spawning was the object of these fish they would have remained longer than two days and a half, and that some would have been caught in former years. From a critical examination and comparison of these with those common to the coast I can find no difference except in size. Finally, as the spawn of these fish appeared matured, I am of the opinion that they spawn in the ocean, and in the month of November. (Since the visit of bluefish, rock and perch, usually quite plenty, have entirely disappeared.)

22. Sexes are mixed.

23. No.

28. Yes, in thousands, near the shore from Cape Henlopen to above this river. It is a peculiarity of the young fish in a strong current to spring from the water, causing persons unacquainted with the habit to remark that "the water is alive with fish." So it is to a certain extent, but it is difficult at such times to find any other kind of fish in it.

29. I saw a great many of the large fish handled, but in no instance did I see the spawn escape, nor do I think it ever occurs with this fish.

30. I have no knowledge of the destruction of spawn, and do not believe the parent fish capable of devouring either spawn or young fish, but instead obtain their food from the mud. The worst enemy of young fish, by all odds, is the sea-trout. From one to three may be found in the stomach of almost every trout, and as trout remain here, more or less plentiful, till September, an immense number of young fish are destroyed. Bluefish is the next most destructive enemy. Other kinds of fish trouble them very little compared with the two above named.

31. I have never examined the roof of the mouth, but have frequently noticed a little bug-like crab attached to the gills of medium sized fish. During August and September it is common to see a slender red worm or leech fast to the fishes' sides. The worm is largest at each end, is about one inch and a half long, and bears some resemblance to the angle-worm. As many as a dozen are found on some of the fish. Al-

though the worm seems as frail as a strand of blood, it is strong enough not to break when its head is pulled away from the fish.

32. The larger fish appear to suffer most from bluefish, although porpoise, shark, and the fish-hawk destroy a great many.

33. None that I am aware of.

34. Mostly in haul-seines, many in gill-seines, but in neither seine is menhaden the object.

35. Seines are from 15 to 100 fathoms long, from 6 to 9 feet deep, and have 1-inch meshes.

36. None. Four-oared boats are generally employed to lay out and draw the seine ashore.

37. From eight to ten men are necessary to manage a boat and large seine.

38. Flood and high tide; sometimes on the ebb, but never at low water.

39. Flood and high water are the most favorable times.

40. The fish usually works against the wind if there is much of it.

42. Some leave the fish on shore, others feed them to hogs, or compost them to enrich their land.

58. I am confident, from observation, that catching large numbers of any kind of fish in the spawning season will diminish them, but owing to this fish not spawning on this coast, I regard it next to impossible to decrease their numbers by any method of capture known to fishermen.

58. *Statement of Benjamin Tice, Maurice River Light, January 11, 1875.*

1. Known by the name of mossbunker or aldwives.
2. They are more abundant than any other kind.
3. Increased in numbers, I believe.
5. No establishment in this vicinity.
6. They come on early in the spring, and are thickest in August.
7. They swim high and make a ripple on the water.
16. Young fish are seen in the months of August and September.
17. Leave the coast late in the fall and by degrees.
31. I have seen worms attached to the outside.
32. They suffer from the attacks of sharks, porpoises, &c.

59. *Statement of Joseph B. Benson, Bombay Hook, Del., January 18, 1875.*

1. Mossbunker, old-wives, bug-fish, and green tails.
2. They are more plentiful than any other fish during July and August.
3. It has not.
4. There is no establishment on the west side of the bay.
5. It does not.

6. The last of April, July, and August they are about the same size. There are no certain intervals in the schools.

7. At times the surface of the water is covered for long distances, and at other times they swim deep. They attract fishing-hawks, which live on them.

8. They come on in the spring and leave in the fall.

9. They are certain to come, but if the season is very wet they are later.

10. It does not.

11. It does not make any difference.

12. Near shore.

14. They like it warm.

15. They are all alike.

16. In August and September there are large schools of them.

17. In October, by degrees.

18. By the capes.

20. It is not known.

21. Where the water is brackish.

28. Some seasons they are abundant near the shore and at other seasons there are none.

30. Rock. Taylor fish.

31. There is a bug found in the roof of the mouth.

32. They suffer to a very great extent.

33. I have not noticed any.

34. Gill-seines.

35. One hundred to 150 fathoms.

36. They are only caught for bait.

38. Whenever convenient.

39. No.

40. No.

41. There are none.

42. They are often taken for manure.

43. There are none.

44. There is none made.

58. It does not.

60. *Statement of Hance Lawson, Crisfield, Md., January 22, 1874.*

Not a report with reference to Atlantic coast.

1. Alewife.

2. Most abundant.

3. Diminished.

4. At Manokin factory 800 barrels of oil were made last year. At Tangier Island about the same or less.

5. Yes.

6. They are first seen about May 1.

7. They swim both high and low; when high, with their heads out.
8. They come from the south, moving along slowly with the tides; up in the spring and down in the fall.
9. There is sometimes a scarcity, but never a failure.
10. They do scare them badly.
11. They come into creeks with the flood and go out with the ebb; sometimes, however, they come in at night.
12. Generally deep water; however, they sometimes work in-shore on the flood tide.
13. A depth of 10 or 12 feet is preferred. They swim on the top of the water.
14. Cold weather makes them torpid.
15. Seldom, and the sizes go in separate schools.
16. They are never seen on the coast, but are in the sounds, rivers, creeks, and bays.
17. They begin to leave during the latter part of August, and the first to leave are the best; some remain until the middle of October.
18. By a southern route.
20. They feed on a slimy substance which comes from the bottom; it looks like a discoloration of the water, but is composed of vegetable or animal matter; the large bodies break into small ones at night and go near shore; in the morning they gather again and go out.
21. At the heads of rivers and creeks, and near fresh water. They spawn in June and July.
24. The water must be warm.
26. I think they float.
28. They are found in abundance in shoal water, where the fresh and salt water mingle.
29. No.
30. Bluefish and porpoises destroy them, but the parent fish do not.
31. Crab-lice are found in the gills, and there is a five-pronged insect, which makes a sore, seen in the tail; we call these insects graplings.
32. They suffer greatly, but are very active; the bluefish is their worst enemy.
33. Never knew of it.
34. Haul-seines, purse-nets, gill-nets, and weirs.
35. Haul-seines are 100 fathoms long and 8 feet deep; nets are 200 fathoms long, and from 18 to 20 feet deep.
36. Barges are mostly employed, and vessels of from 10 to 20 tons burden.
37. Twelve men for purse-nets and 25 for haul-seines; one man for gill-nets.
38. All hours of the day and night. Gilling is done at night.
39. No.
40. Yes; it scatters and sends them down deep.
41. Five vessels averaging about 15 tons, and 5 barges.

42. They are made into oil and manure, and sold to farmers.
43. Tangier belongs to Crockett & Co., Manokin to Ford, Avery & Co.
44. About 800 barrels at Ford's, and 500 at Tangier.
46. The fish are boiled in large kettles at Tangier, but are crushed at Manokin. The Tangier and Manokin factory cost each \$2,500.
47. Fifteen cents per bushel.
48. About 1,000 fish, or from 4 to 4½ bushels.
50. One quart, and is least in July.
51. One and one-half gallons, and is greatest in August and September.
52. Yes, as much again.
54. Philadelphia and other cities.
55. Home.
56. Used for lubricating purposes.
57. From 40 to 60 cents.
58. Yes.

61. *Statement of Isaac D. Robbins, Hog Island, February 21, 1874.*

No efforts are made here to catch the mossbunker. We have them during the largest part of the year, from April to September, and sometimes in winter. I once saw many of these fish in Swangut Creek which had died from the effects of hot weather; they were then about 2 inches long. In the fall we see them from 3 to 5 inches long. We make no use of these fish, but I have an impression that there are enough of them to make our land very rich if they were made into manure.

On the Chesapeake side of the peninsula I have known large quantities of these fish caught, and a few years ago some gentlemen undertook to convert them into oil and manure, but to what extent they were successful I cannot say.

The grown mossbunker is from 9 to 12 inches long, and generally very fat.

62. *Statement of J. L. Anderton, Apateague Island, Virginia, January 12, 1875.*

1. Alewives.
2. They are more abundant than any others found in this vicinity.
3. Increased.
4. There is no establishment in this vicinity.
5. It does not in this vicinity.
6. First seem to come near the coast in April. The main body appear in June. The first are the smallest.
7. They swim high, make a ripple on the water, and attract birds.
8. They come from a southward direction.
9. Their appearance is regular and certain.

10. No.
 11. They come nearer the shore on the flow of the tide and move off on the ebb.
 12. On bars and in coves.
 13. Four and a half to five feet. They swim nearly to the top of the water.
 14. It does.
 15. They come before they are mature, and we find the one and two year old fish with the oldest.
 16. They are seen on the coast from April till June, from 4 to 10 inches in length.
 17. They leave in November by degrees.
 18. They go southward.
 19. Somewhere south, I think.
 26. I think they float.
 29. Yes.
 30. Don't think the parent fish devours them ; birds eat them.
 31. Lampreys are sometimes found attached on the outside.
 32. Quite considerable.
 33. I have not noticed any.
 34. None in this vicinity, except small gill-nets.
 42. There are but few caught in this vicinity. They are used on the spot.
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63. *Statement of G. Henry Seldon, Kinsale, Westmoreland County, Virginia, August, 1874.*

1. Alewives.
2. More abundant than any other fish.
3. Diminished very much within the last ten years, particularly in the small rivers.
4. From 5,600 to 6,000 barrels taken in 1873 by one establishment in this vicinity. This is about the average number of barrels taken each year.
5. The capture has a tendency to affect their abundance.
6. They appear in Chesapeake Bay about the 10th of March. The main body arrives about the 15th of April. The first fish are the largest. They come in quick succession.
7. They appear in schools, but swim low. There is therefore no ripple seen, and their arrival is known only by their capture, and the attraction of birds.
8. They come up the coast from the south ; their movements are very swift, passing to the headwaters of the bays and rivers, where they are seen to linger a short time to spawn ; then returning, they leave our coast and go to the coast of New England.
9. They are never known to fail.

10. They do not appear to be scared by seines or nets any longer than they are in sight of them.

11. Their migration is more on the ebb tide, as they stop on the flood tide to feed.

12. In large bays and rivers where the bottom is soft.

13. From three to eight fathoms of water. When the weather is cool they swim deep, but come near the surface at times; these times can be ascertained by the birds striking them. When the weather is warm these fish are seen to swim with the tops of their heads out of the water.

14. As the mercury sinks they swim deeper in the water.

15. They seldom appear on their breeding grounds before matured. The one and two year old fish are not found among the oldest.

16. The young fish are seen on the coast about the 1st of June, at which time they are about 4 inches long.

17. They leave the coast generally in the latter part of October in a body.

18. They leave the coast by the southern route going south of course.

19. It is thought that they spend the winter in or beyond the Gulf Stream, where the water is warm.

20. There is a sediment upon which they feed; this they purify by straining it through their gills.

21. They spawn in the headwaters of our bays and rivers, generally in the month of April.

22. In their migration movements they are mixed indiscriminately, as may be seen from the manner in which they are caught in the gill-nets; but when coming upon the breeding grounds, they are not huddled in schools, as may be seen afterwards.

23. The milt of this fish does color the water.

24. Cannot tell the exact temperature of water which is most favorable for spawning, but I think when it is from 45° to 65° ; when the water is cold they spawn in the deep where the cold winds cannot chill the spawn; when the weather is moderately cold, it does not destroy the spawn, but the young fish will not hatch as soon as when the water is of the right temperature. Where the water becomes heated by the burning rays of the sun the spawn is instantly destroyed.

25. In from 4 to 10 feet of water; the eggs lay on the bottom. Where it is soft, and produces a little grass, it is all the better for the spawn.

26. When the eggs are spawned they sink to the bottom, but become attached neither to stones, grass, nor any thing of the kind; neither do they float until hatched, but lay on the bottom.

27. In four or six days' time after the eggs are laid they begin to hatch out. It has been said that they hatch out in two days after they have been laid, but this is very seldom; however it is not impossible, but my own experience teaches me that to hatch them out in two days would require the tide, locality, and temperature of the water to be very favorable.

28. The young of this fish are found in great abundance in the headwaters of our bays and rivers, generally near the shore.

29. The spawn is never known to run from this fish while being handled after they are captured.

30. The parent fish does not destroy the spawn, but other fish, such as the rock-bass and the pickerel destroy the spawn of this fish.

31. The lampreys are often found attached to the outside of this fish. In their gills and roof of the mouth is found an insect as large as the end of a man's small finger and three-quarters of an inch long. This is the small size of this insect. I have seen them an inch and a quarter long. It is transparent and has a tail resembling that of a lobster; and so great is the adhesive power of this insect, that you might attach one of them to your finger while it is alive and you could not throw it off. This insect is known to us as the fish-louse, because it attaches to the inside of the head of this fish; they are known in many localities as the buggy-head fish.

32. The bass, trout, bluefish, sharks, and the porpoises all feed upon this species of fish.

33. No disease of any description has ever occurred among them, causing death in any numbers worthy of notice in the past thirty years.

34. Purse seines, gill-seines, haul-seines, fike-nets, and hedge-nets are all used in capturing these fish, and are generally used with great success.

35. Seines for capturing this fish are from 50 to 400 fathoms long, from 2 to 5 fathoms deep, and of a 2 or $2\frac{1}{2}$ inch mesh. The seines used at the oil factories are called purse-seines; they are about 100 fathoms long and 500 deep.

36. Small-size schooners and sloops, being from 6 to 20 tons burden.

37. Two men to each vessel, except the tug, which has 5 men.

38. Toward midday is the most successful period for catching these fish.

39. They are taken in greater numbers on the ebb tide.

40. They do not appear upon the surface of the water in windy as they do in moderate weather.

41. Seven vessels are employed in this vicinity having crews of 15 or 18 men, but the aggregate number of men at the factory and on board of the vessels is 45 or 50.

42. The fish thus caught are taken to the factory and there boiled up for oil.

43. The only factory in this neighborhood is the one at New Point Comfort, owned by Nickleson & Co., of Norfolk, Va.

44. The average quantity of good oil produced by this one factory is about 300 barrels a year.

48. One bushel.

49. Probably 10 gallons.

50. Probably $2\frac{1}{2}$ gallons in the spring and summer.

51. Probably 3 gallons. The greatest quantity of oil is obtained in and after the month of September.

52. Yes.

54. New York.

55. Virginia and North Carolina.

56. For tanning leather, painting, machines, &c.

58. Yes.

64. *Statement of Henry Richardson, Cape Henry, February 9, 1874.*

1. The "alewife," termed by some "bony fish."

2. These fish are more numerous than any other fish that inhabit these waters.

3. During the last four years (the length of time I have been in charge of this station) there seems to be no diminution in the numbers of these fish.

6. These fish are caught as early as March, but the main body arrives about June and July. During these two months these fish are constantly passing the Virginia capes, entering the Chesapeake Bay. I have seen schools of these fish on calm days in the summer season, I should judge, about two miles long and perhaps one-fourth of a mile wide.

7. These fish swim high, or near the surface of the water, and their approach can easily be seen by the commotion they make. They ripple the water and also attract the attention of birds.

8. They work in the spring of the year from south to north. I do not know their subsequent movements after their entrance into the Chesapeake Bay.

9. I have never known these fish to fail to enter these capes during any season.

11. During the summer season they work in and out of the capes, working out with the ebb tide and working in again on the flood.

13. They swim in shoal as well as in deep water, and create a constant flipping on the surface.

14. In unusually cold weather they get benumbed, and sometimes wash on shore in great quantities.

16. The young fish commence coming about June, and average, I should think, about five inches long.

18. They follow the Atlantic coast and work south.

19. I have been informed that they winter around the Bahama Banks and the West India Islands.

20. Their flesh is very sweet early in spring and late in the fall of the year, but they are objectionable as food on account of the quantity of bones they possess.

31. In the summer season they become wormy. These worms have the appearance of a fine piece of red string about one inch long. I have pulled them out of the side of the fish, and the root or end of the worm in the flesh has the appearance of an eagle's claw.

34. A purse-net ; although they are caught in large quantities frequently in the summer season with long seines. These seines are used for catching the more edible species of fish, and when "alewives" are caught by these seines they are left to rot on the shore.

42. These fish are caught about the entrance of the capes or in Chesapeake Bay, put on board of the small schooners employed in this business, and thence taken to the factories, where the oil of the fish is extracted and the refuse manufactured into fish guano or fertilizer.

43. At the present time there are no factories for the manufacture of fish-oil in this neighborhood. A factory for this purpose was in operation some two years ago, but it has since been consumed by fire.

58. There does not seem to be any diminution in the quantity of these fish, and thousands of bushels are annually destroyed on this coast by the seines used in catching the more edible fish that supply our markets. They might be used to good advantage in manuring the land in the surrounding country, but the difficulty of transporting them to lands used for agricultural purposes is so great that they are left on the beach to rot.

65. *Statement of C. G. Manning, Edenton, N. C., January 6, 1875.*

I have the honor to acknowledge the receipt of your circular-letter under date of December 23, 1874, making inquiries relative to the fish known in our vicinity as fat-back or bug-fish, and in reply thereto I would state I have conversed with several of the leading fishermen on the Albemarle Sound and its tributaries, and they report very few of that class of fish caught during fishing season. Those which are caught are disposed of by being thrown in with the offal or refuse fish, afterward used upon their lands in a raw state as fertilizers.

The fishermen attribute the scarcity of that species of fish in the upper part of the sound to the freshness of the water. I have been unable to obtain any information from the lower part of the sound, where the water is brackish or salt.

1. Bug-fish.
2. They are very scarce.
3. Diminished.

66. *Statement of A. W. Simpson, jr., Cape Hatteras, N. C., April 15, 1874.**

1. Fatback.
2. It is not found throughout the year. It makes its appearance in June and leaves in December.
3. It is not resident.

* The numbers of this communication refer to the general circular published in the first volume of the report of the Commissioner.

4. It is more abundant than any other fish that frequent the waters of North Carolina, say 5 to 3.

5. They have increased in abundance within the last ten years.

6. The supposed cause is that their enemies are not so numerous.

7. The amount or extent of the change in abundance cannot be ascertained.

8. The greatest length to which this fish attains is about 16 inches.

9. The rate of growth per annum, &c., is not known by any one in the community, no attention being paid to it.

10. The sexes differ somewhat in shape and size; the male is as long but not so large as the female.

11. These fish generally come in to the shore on the northern coast, and run along the beach south, running into the different inlets. In the first of the season they may be seen, in moderate weather, five or six miles at sea in large schools, half a mile long and all along the coast, lying apparently at ease floating upon the surface of the water. This habit they indulge in until the latter part of October, when the bluefish or taylor arrives; then they seek protection in the surf near the beach, and are washed ashore by thousands. I might be safe in saying hundreds of thousands are washed ashore in one night or during one flood-tide.

12. They continue to run south, or rather are driven by the taylor until December, after which only a very few are seen in the sound.

13. It is unknown to any one here where they spend the winter season.

14. The fish come near the shore upon their first arrival on the coast, but the main body does not come in until driven in by the taylor and dogfish about the first of November. The first are generally the smallest. I think they are continually on the coast from the time of their arrival to the time of their departure; but sometimes they are seen in larger quantities than others, say once to twice a week.

15. In some seasons the fish leave the shore in a body, and at different times during the season; but when they leave the coast for the south they go by degrees, commencing about the first of December.

16. The appearance of these fish in the sound, and at sea off the coast, is certain every season; but they only come near the seabeach when driven in by the taylor and dogfish.

17. The runs do not differ, except in quantity. Some seasons the runs are very large in October; but in November they are not so plentiful, and *vice versa*.

18. As far as my knowledge extends, both sexes come in together. The spawn is about two-thirds developed when they first arrive.

19. These fish never take the hook.

20. These fish never take the hook.

21. The schools of fish swim high in moderate weather, but in high winds and rough seas they run in deep water. Their arrival is sometimes known by the schools which are seen at sea, lying at ease appa-

rently, with a continual flipping motion with the tail above water; this attracts thousands of birds.

22. They generally come on the beach on flood and drop off on ebb tide; they also run into inlets on the flood.

23. Spawn is sometimes seen when the fish are handled to any great extent.

24. The spawn is also seen around set-nets, when the fish force themselves through the meshes.

25. The fish are anadromous; they run up the fresh-water rivers for the purpose of spawning, and to "suck" (eat) the scum generally brought down by freshets.

26. They sometimes make several trips up the rivers, and returns in the sound, before going up to spawn; this is attributed to the number of freshets during a season. Some seasons they make no stay in the sounds, but go right up the rivers on their first arrival, and continue these visits until December.

27. See answer to question 26.

28. There is no difference in this respect as to sex or age known to me.

29. The young fish are generally mixed up with the old ones when in large bodies or schools; but, as a general rule, the young are seen along the shores of rivers and sounds.

30. The favorite localities of these fish are varied as in other cases. In moderate weather they float high, in fact upon the very surface of the water, and feed upon the scum or mud which are afloat. They then select some place near a lead or tide way, but often shelter themselves behind a shoal or breaker where the current eddies; but in windy and rough weather they are constantly running.

31. They generally prefer the deepest water to school, as stated in answer 21.

32. There has been no difference observed, by me at least, as to the favorite temperature of the water, but they are more abundant when inside the sound in thick, milky-colored water.

33. These fish are not seen in schools after they are done spawning; but the general opinion is they are in schools when leaving the sounds and rivers, judging from the quantity taken or caught in set nets of a night. They are not seen at all in moderate weather, as described in answer 21.

34. They have no special friends; but the porpoise, the shark, the dogfish, and the taylor are special enemies of the old, and the crab, the eel, the perch, trout, and several other species of fish, of the young fish.

35. The fatback do not prey upon or eat any other species of fish during their stay in this section.

36. They suffer to a great extent from the attacks of other fish, but the amount is not exactly known. I think, however, I would be perfectly safe in saying that at least half are destroyed.

37. The nature of their food is mud from the fresh-water rivers, scum, &c., afloat on the water, and marine insects, which are found along shore and on the reefs in the sounds and rivers.

38. There are no special peculiarities in the manner of feeding these fish known, no attention having been paid to that particular.

39. Nor is it known what amount of food they consume. When taken, the stomach or pouch is generally full of mud, and they are very fat until they have spawned.

40. The sexes differ somewhat in color and shape during the breeding season, the male being of a pale-yellow and the female a bright-yellow color in respect to their fins and tails. The male is equally as long, but of a more straight shape. The edges of the females are generally tinted with bright-yellow specks.

41. There are no special or unusual habits of these fish during the spawning season known to me.

42. Lines and nets interfere somewhat with their progress up the rivers, but aside from this spawning is not interfered with to any great extent by lines and nets.

46. According to my views, from their movements and not from actual knowledge, these fish deposit their spawn in the beds of the principal rivers—the Neuse, Tar, and Roanoke—about the last of November.

47. I can give no account of their process, &c.

48. The water is sometimes whitened by the milt and spawn.

49. They generally select the warmest places for spawning, but the exact temperature is not known; it varies from one to ten degrees, owing to the weather.

50. The eggs are laid in two to three fathoms of water, and supposed to lie on the bottom.

51. The spawn is of the size of a mustard-seed, and of a light-red color.

52. The number for each fish has not been ascertained.

53. Either for one season or for lifetime.

54. The eggs when spawned sink to the bottom, but whether they become attached to stones, grass, &c., I do not know.

55. It is unknown whether the fish heap up or construct any kind of nests of sand, gravel, or grass.

57. It is not known by any one on the coast when the eggs are hatched or in what period after they are laid.

62. They are never seen carrying them in their mouths or otherwise.

63. The crab, eel, perch, trout, and several other species of fish destroy the spawn and the young fish. The parent fish never interferes with either.

64. The young of this fish are found in great abundance on the shores of rivers and sounds.

65. They appear to feed the same as the old ones, as described in answer 37.

66. No steps have been taken to increase the abundance of this fish by artificial culture.

67. These fish have no protection from any source.

68. No epidemic or other disease has ever been noticed among them on the coast.

69. If such has ever taken place, the time and cause are unknown.

70. Worms and lampreys are found in the gills and about the fins of these fish.

71. The fish are caught in nets.

72. For ordinary purposes in set-nets of from 50 to 60 yards long, $1\frac{1}{2}$ to $1\frac{3}{4}$ inch mesh, and from 20 to 30 meshes deep. These nets are generally set at night with both ends made fast, and remain in the water during the entire night, so the fish are caught in the night-time. But when they are caught for the purpose of manufacturing into oil and manure, they are hauled ashore at the inlet and on the sea-beach with large seines, or taken with purse-nets. This latter performance can be done more effectually in moderate weather when the fish are in schools.

73, 74. It may be taken in nets from the 1st of October to the 1st of December. They are never taken with hook.

75. One good seine, of proper size to suit the depth of water, might haul ashore in a day at least 100 barrels of fish along the beach. This is only at times when the tailors drive them in to the beach. In some seasons we might get ten, in others not more than two, good days' fishing.

76. A purse-net will take of a good day 15 to 20 barrels, while a set net only 4 to 5 in a night.

77. It is caught more on flood-tide than on ebb, for they go off shore on ebb-tide.

78. The fish caught are used on the spot, except occasionally some are taken at sea in purse-nets by vessels connected with some oil-factory on the northern coast.

79. It is an excellent food, fresh or canned and smoked.

80. It sustains its excellence as a fresh fish only a short time, owing to the temperature of the weather.

81. It is eaten to a great extent by the fishermen and others along the coast.

82. It is salted down in quantities only to save from one season to another.

83. It has been used for oil and manure to some extent, but there is no establishment of this kind on the coast at present.

84. These fish are not carried to market in any abundance, but when any are sold they are worth from \$8 to \$10 per thousand. The prices vary according to the quantity of fish in market.

85. These fish have never been exported from North Carolina.

86. The principal market of the fatback is in country places among farmers and freedmen.

67. *Statement of A. W. Simpson, jr., Cape Hatteras, N. C., January 20, 1875.*

During the past season the fishermen provided themselves with seines and boats in time to meet the first run of the bluefish. The seines were made of cotton marlin, and were about 100 yards long, 2½-inch mesh, and from 40 to 50 meshes deep. The bluefish made their first appearance on the coast from the north. The menhaden passed about three days in advance of the bluefish. I do not think I ever saw so many of this species at any one other time or in any one other season. From the balcony of the light-house at least twenty-five schools might have been seen lying along the coast, both north and south of the cape. Each school seemed to cover many hundred yards of surface and to be moving south at the rate of from four to five miles an hour. This continued, and school after school followed, for ten days before the appearance of the blue-fish, and when the blue-fish did appear there seemed to be more of the menhaden with them than had passed the station during the three previous days. Hundreds of barrels, I think, were washed ashore, and were driven so close by the bluefish that they had not the power to resist the surf, which was quite rough and heavy, and they were consequently thrown ashore upon the beach. Only a very small quantity of these fish were saved, as the fishermen gave their attention more particularly to the bluefish; but some of them were saved and salted down, when they were sold to a good advantage. Some sold as high, in trade, as to bring ten bushels of corn, equal to \$7 in currency, for one common fish-barrel of the menhaden. It has been generally thought by old, experienced fishermen here that the bluefish drive the fatback south in winter; but I have learned differently during the past season from personal observation, which the following fact strongly attests. The menhaden came three days in advance of the bluefish, and entered the sound at all the principal inlets, and made their way directly for the fresh-water rivers. They could be seen as numerous in the sound, heading north, as they were in the sea heading south. Furthermore, by a letter from a gentleman of Plymouth, N. C., I hear that they passed that place, eight miles above the mouth of the Roanoke, in five days after passing this station, and by another letter, from Windsor, 38 to 40 miles above the entrance, I hear that they arrived there as early as the 18th of December. Thus it may be readily seen that the bluefish are not the cause of the fatback coming south. I would sooner think that the fatback caused the bluefish to come south in winter, as they generally follow in the run and among the last of the run of the fatback.

Last year there were not so many of the menhaden, but there were millions of young spat—about two years old; however, this winter there was not a spat to be seen, but the gray trout came instead. These, too, were washed ashore in great numbers. I feel safe in saying that if

the fishermen had provided themselves with material for saving menhaden and trout, there might have been double the sum realized that there was by bluefish, although there were very many bluefish caught. There were engaged on the coast of Dare County twenty-five to thirty boats, each boat containing one seine and three men; these were scattered promiscuously along the coast, and, I think, from a rough calculation made since I wrote you last upon the subject, that the catch for the season averaged about two thousand to each boat and crew; making in all over fifty thousand bluefish. These fish sold for from fifteen to as high as fifty cents each. I have not heard of any being sold for less than fifteen cents cash. Many of them were traded off for corn, flour, and such other articles as this place does not produce. I think that there will be very extensive preparation made for this business next winter, and also for the menhaden. There is no need of making any preparation for catching the menhaden; more will be driven ashore than can be saved.

68. *Statement of A. W. Simpson, jr., Cape Hatteras, N. C., January 25, 1875.*

1. Fat-back.
2. Heretofore only about one-third more abundant than any other species, but I have seen twice as many fat-back during the fishing season of 1873 as I ever saw of any other species on our coast.
3. It has increased.
4. Only about fifty barrels.
5. Neither capture nor the destruction of the fish on the coast by the bluefish seem to affect their abundance.
6. There are generally two runs; in other words, the fat-back comes south in spring, and some are seen in the sounds and rivers all the year; but when they come south for the purpose of spawning, they come sometimes in November and at others in December. In 1873, they were first seen on the coast about the 6th of December, and the main body arrived about the 10th of December. I did not notice any difference in the size of the fish in the different runs. There are generally more schools than one; many schools may be seen at one time. They seldom come near the coast in high winds and rough seas, but when they do, they swim so low that they are not seen from land.
7. The schools of fish swim high in moderate weather, and low in high winds and rough seas. Their arrival is generally known by the birds and by the ripple they make on the water. They are a great attraction for birds.
8. I do not know by what route they come into the coast north of this place; they come down along the coast from the north, enter the sounds at the principal inlets, and go up the rivers at once; they generally go from four to five miles an hour.
9. The appearance of this fish on our coast is certain, and they are

about the same as to abundance every year, when the spring run comes in; but the fall and winter run varies somewhat; some seasons not half so many are seen as at others. I do not know of any real cause for this difference.

10. Only for a short time; they will return to their feeding-ground in less than two hours after having been scared away by a net.

11. In winter I do not think the ebb and flow of the tide affect their movements any more than they choose to run against the tide. More of them enter the sounds from sea on ebb than flood tide. In spring and summer they frequent deep water on the ebb and shallow water on the flood tide.

12. During spring and summer they feed in muddy slues and channels on the ebb and grassy reefs and shoals on flood tide; in moderate weather, during the day and at night, they seem to drift up and down the channels and sounds with the tide, either ebb or flow, and in high winds they are continually running.

13. They do not seem to be particular about the depth of water, as some at their feeding-ground are in deep channels and others are in shallow slues. They swim on the top of the water in moderate and near the bottom in stormy weather.

14. They prefer the warmest water.

15. From what I have been able to learn they do not come on the breeding-ground before they are mature. Some small fish are seen in large schools, but not as a rule; the one and two years old school are by themselves.

16. The young fish are seen in the sounds, creeks, and rivers all the summer, from one to three inches long. I remember, one day during last August, twenty-five miles above New Berne, I could see 50 schools at once, from one to three inches long, and I noticed they were more numerous nearer the mouth of the river; these come down on the coast, and feed along the shores of the sounds and in the creeks until they are large enough to go to sea.

17. I think they have various ways for leaving the coast; some seasons they may be seen going to sea in large schools, and at other times they go off gradually. They leave by two runs; those that come in November or December leave about the middle of January, and the spring run leaves in October.

18. They return north by the same route they came south.

19. They spend a part of the winter in our principal fresh-water rivers, and in the sounds and creeks; where they go after going to sea I do not know.

20. Mud and scum from the surface of the water and insects which they find among the sea weed or grass is their principal food.

21. These fish spawn in the Neuse, Pamlico, and Roanoke Rivers some time during the month of January.

22. From what I can learn they are mixed indiscriminately.

23. The water is colored to some extent; it being already of a milky color, it is hard to ascertain; but it is colored some by the milt of the male.

24. I do not know the exact temperature.

25. The eggs are laid on the margin of the river, generally in from 6 inches to 2 feet depth of water.

26. The eggs float about the river; some of them are even seen to drift ashore, when the water falls away, leaving them dry; this destroys them.

28. The young are found in great abundance in the rivers, sounds, and creeks.

29. Fishermen on the rivers say that the spawn runs from the fish when handled after having been in fresh water two to three days; but it never happens while they are in salt water.

31. Lampreys are sometimes found attached to the gills, and a kind of a bug in the roof of the mouth; but I never heard of crabs being attached to them.

32. They must suffer to a great extent from the attacks of the bluefish, shark, and porpoise. I noticed that each bluefish caught on the coast this season had from one to three fatbacks in the stomach, showing that many thousands, and I might say millions, are destroyed by the bluefish alone.

33. I have never known of any epidemic among the fatback.

34. Drag-nets at the sounds, and set-nets at the rivers. These are made of gill-twine, No. 25 or 30, and cotton warp spun into cord.

35. The drag-net is from 75 to 100 yards long, having a mesh of from $1\frac{1}{2}$ to 2 inches, and from 25 to 35 meshes deep. The lower or lead line is kept on the bottom by sinkers made of lead for the purpose; and the upper or cork line is kept on the surface of the water by floats made of dry gum-root made for the purpose. The set-net is made of gill-twine, of from 35 to 45 yards long, and from 18 to 20 meshes deep, the mesh being from $1\frac{1}{2}$ to 2 inches. A coarse selvage made of cotton twine, dipped in tar and then dragged or rolled in coarse pebbly sand, answers the purpose of lead sinkers. A cork line buoyed with gum-root corks keeps the net off the bottom. These are called fly-tale nets. They are placed in the water on the feeding ground in the evening, and allowed to remain all night.

36. Canoes (not tonnaged) are used; some of them are only 16 feet long by $3\frac{1}{2}$ feet wide, while others are 30 by 7.

37. Two men are sufficient to manage the small canoe, and three the larger ones.

38. Both day and night flowing water is preferred.

39. They are taken more plentifully in the flood-tide.

40. Moderate weather is preferred for fishing with the drag-net, and high winds for the set-net; as they are feeding in moderate and running in windy weather.

41. There are no particular number employed in catching the fatback, as that is not made a specialty. The fishermen in this vicinity have nets to suit, and look after all kinds of fish. About 200 boats are employed in the two townships adjacent to this station, with an aggregate number of men amounting to about 500.

42. Some of the fish caught during winter are used on the spot, and some are carried to the country towns, villages, and farming districts and sold, while those caught in summer are used for manure.

43. There are no oil-factories here.

47. Seven dollars per barrel was paid for menhaden in 1873. I have no account of previous years.

58. The catch does not appear to diminish them.

69. *Statement of Wallace R. Jennett, Cape Hatteras, N., C. February 26, 1874.*

1. Menhaden and Fatback.

2. They are more abundant and less cared for than any of the funny tribe.

3. They are not so abundant as ten years previous.

6. They arrive in October and November principally, and may be found to be larger at the time of their departure.

7. The fish generally are seen upon the surface of the water so as to attract birds.

8. They come from the north, caused by the prevailing winds at that season of the year.

9. Yes.

10. They seem nowise sly, and are very regularly driven from the regular course.

11. On the ebb and flood alike; they are seen to float without any material difference, having no particular favorite locality.

13. They prefer deep water, and are, so far as we can see, not affected by the temperature.

15. The fish on their arrival seem to be of the same age and size, no young fish are seen at all.

17. They leave in the early spring and go south.

20. Sediment and mud from the water and fine grasses.

22. The fish seem to mix indiscriminately; the sex is hardly to be observed at any time; it is not likely that they spawn on this coast at any time.

23. The water very rarely changes its color among the fish, consequently no milt is discharged.

28. There are no young fish found in this locality.

29. The spawn is never seen to run from the fish as from the shad, rock, perch, and others.

31. Crabs, lice, and other living animals are found attached to them at times in the gills and on the backs.

32. They fall an easy prey to sharks, bluefish, and porpoises; thousands are thus destroyed, furnishing food for other fishes that may follow in their track, such as drums, trout, &c.

33. Epidemics and distempers are very rare, but are sometimes prevalent; at which time they have drifted ashore in such abundance that the stench has been fearful.

34. They are caught and taken with immense purse-nets, made of cotton twine, 200 fathoms long by 25 to 30 feet deep.

36. Sloops or cat-boats are used to carry seines and men, at least 3 or 4 in number, with an aggregate of 25 men.

38. The entire day is often used in catching these fish.

40. The wind at all times seems to affect them, as they are seen frequently running before it, and in quick motion.

41. At the present time there are no arrangements made to capture the fatback. The business has not seemed to pay, for want of transportation.

42. The fish when caught were used on the spot. The oil was pressed from them by hydraulic press, and the refuse was used as fertilizer.

58. It is probable that the fish caught does tend to diminish their numbers and quantity.

70. *Statement of A. C. Davis, Beaufort, N. C., February 14, 1874, and January 27, 1875.*

1. Fatback.

2. More abundant than any other species.

3. Increased.

4. No establishment in 1873; cannot state for other years.

5. Does not.

6. In June; main body arrives in July; increase in size after arrival, and are largest in October. Schools are constantly coming in (in the season) at short intervals.

7. Swim on the surface except when disturbed; they then sink, and in a short time reappear. Arrival is known only by their appearance in schools on the surface of the water. This latter, perhaps, may arise from the fact that about the time of their first appearance no fishing is carried on by nets; it is, however, generally considered that their arrival is first known as stated. They make a distinct ripple on the water, and are easily known from other fish. They attract birds, &c.

8. Southward, ascend the rivers, drift in schools up and down with the ebb and flood tides.

9. Regular and certain; they have never failed; seem to return in greater abundance; perhaps this is due to the fact that only a small quantity have been captured yearly in this locality.

10. Are taken by nets, &c., inside the inlets; are easily taken. The

use of nets does not scare them further from the shore, but the rivers are not very wide.

11. Always swim or drift with the tide.
12. In the channels of the rivers.
13. The deepest; when attacked they swim near the bottom.
14. Are not seen after October, or, say, early in November.
15. Do not breed here; they arrive here one-fourth to one-half grown; neither two-year old fish nor the oldest arrive at their first appearance.
16. Not less in size than named in 15.
17. Main bodies in October and early in November, by degrees.
18. Proceed south.
19. Southward.
20. Having no teeth, they feed off the slime, scum, &c., on the surface of the river.
21. Further south; cannot say where. I have given this matter some attention, and from what I consider the best information they spawn at sea, not in the rivers, early in the spring.
22. No. On their appearance in the rivers the sexes are mixed indiscriminately.
23. Is colored late in the season, but is only noticed at the time of the "catch" or "take."
24. Not in this locality.
25. Has been found to run in a late catch.
26. Not.
27. Severely from sharks, slightly from porpoises, late in the season; when at the inlets they are attacked by bluefish.
28. Never has.
29. Cotton and gill twine nets, after being partially worn in taking other fish, are unfit for further use after the first season; slime, &c., rot them.
30. Generally 50 fathoms in length; 50 to 60 meshes, of $1\frac{1}{4}$ inches to $1\frac{1}{2}$ inches per mesh, deep.
31. Open boats and canoes only, carrying from 10 to 25 barrels, are used in this locality.
32. Two (2) men to each canoe and net. In making what is called a drop or haul, 4 to 6 nets are used. The school is surrounded, the fish are meshed in the net, shaken from the nets into the boat or taken out of the meshes by hand. The fish are never hauled to the beach.
33. One haul generally loads the canoe; two loads can be made in one day; the time occupied for each load is from 2 to 4 hours.
34. More on the ebb.
35. Are more numerous in moderate weather with southerly winds.
36. Only boats and canoes, as named in 36. Very few were engaged in the business, though enormous quantities of the fish were present in the rivers, during this last season.

42. At this time only, for agricultural purposes on the spot. None are sent abroad.

43. None.

47. Fifty (50) per barrel of $3\frac{1}{2}$ bushels. In previous years, 60 to 65.

50. Three-fourths gallon to 1 gallon at the first run in June.

51. Four gallons to 5 gallons in October and early in November.

52. Are one-fourth larger and yield more.

53. Three manufactories have been established (several years since); but all have suspended operations.

55. Scrap was sold principally at Baltimore and other northern points.

56. Is excellent for mixing with tar, ochre, &c., for painting roofs of houses, also water craft. It is also valuable in applying to cattle, hogs, &c., for the extermination of vermin.

57. In previous years 75 cents per gallon:

58. Does not.

71. *Statement of W. T. Hatsel, Body's Island N., C., March 4, 1874, and February 23, 1875.*

1. Fatback.

2. There are three times as many.

3. Neither diminished nor increased (diminished 1875).

4. Fifty thousand barrels in 1868; Excelsior Works at Ocracoke Inlet; Adams & Co., Beaufort, N. C.; and Church & Co.

5. No.

6. There are two main bodies; one in the spring (April), another in the autumn (October).

7. They swim high and make a ripple, which attracts birds.

8. North and south.

9. Sometimes they fail for a season.

10. No.

11. They scatter at the flood.

12. Around inlets near the shore.

16. Yes, between first and last; approach 3 inches long.

17. In very cold weather.

18. Southward.

19. Somewhere south.

20. They live by suction.

21. In the sounds.

23. Yes, it is colored white.

26. They are supposed to sink.

29. Sometimes.

30. Sharks, porpoises, and bluefish. If the parent devours them it must be done when quite young, or at spawn-time.

31. Worms are found in the gills and outside; lampreys are also found outside.

32. They suffer very much.

33. What the nature of the epidemic is, I cannot say; I have known them to die to some extent.

34. Purse-seines.

35. Five hundred yards long and 50 deep.

36. Cat-boats of 6 tons.

37. Seven men.

40. They move against the wind.

41. I believe there are none in the State.

42. Used for oil and scrap; the oil is sent to New York, the scrap to Baltimore.

43. There are now none.

46. The Excelsior Company's cost \$30,000; Church & Company's cost \$5,000; Adams & Company's cost \$5,000.

47. Twenty-five cents.

48. One barrel of fish produces $1\frac{1}{2}$ gallons of oil.

49. Seventy-five gallons.

52. Yes.

54. New York.

55. Baltimore, Md.

56. For tanning purposes.

58. Does not perceptibly (1874). Yes (1875).

72. *Statement of W. A. Harn, Morris Island, S. C., January 21, 1875.*

In reply to circular dated December 20, 1873, requesting information of fisheries and the habits of fish on this coast, I would say that there are no fisheries near this station, and the only fish that are caught here are the whiting, trout, and sheephead, and those in very small numbers.

73. *Statement of Patrick Conner, Daufuskie Island Light, S. C., March 15, 1875.*

1. Mossbunker, or bony shad.

2. There are five hundred thousand per cent. more than any other.

3. It has increased.

4. None.

5. There is no capture of them to have any effect.

6. In May. The main body come in June; they are; there are.

7. They swim high, make a ripple, and attract birds.

8. I know not their route; they come into the sound and go out with the tide.

9. It is. I never knew them to fail.

10. I cannot say. I never saw them caught.

11. They come in with the flood and go out with the ebb.

12. The bayous along the coast.
13. I do not know. I have seen them in all depths, from 3 feet to 6 fathoms.
14. It does. They never come before it gets warm in May.
15. They do; yes, but generally they go in schools according to size.
16. They are, in July and August, about $1\frac{1}{2}$ inches long.
17. They leave in September; in schools and by degrees.
20. Some sort of insects, or it may be their own eggs; they are constantly sucking in the tide.
28. They are in all the bayous along the southern coast.
20. I cannot say what enemies the spawn has; but shark and blue-fish destroy the young.
31. There is a bug, with several feet or legs, found outside on the cheek.
32. They suffer heavily; but, on account of their very great numbers, are scarcely perceptibly diminished.
33. I do not know of any.
34. No kind. These fish are never captured.
35. There are none used.
36. No vessels employed of any tonnage.
40. High winds do; the small ones are cast ashore in rough weather.
41. None.
44. None.
45. None.
47. None bought or sold.
53. It has no history. There is none manufactured.
54. There is no market, for there is no oil.
55. There is no market; there is no scrap.
58. I cannot say; they are never caught.

74. *Statement of George Gage, Beaufort, S. C., January 20, 1874.*

Referring to your circular of December 20, 1873, relative to the "menhaden fisheries," &c., I have to report that I have no evidence of the existence in this district of either of the species of fish therein referred to. There is no fishing here in a commercial or statistical sense.

75. *Statements of Joseph Shepard, Saint Mary's, Ga., March 30, 1874, and January 28, 1875.*

I have the honor to state, relative to the species of fish known as the mossbunker, that after making inquiries of men who have made a business of fishing on the coast of Georgia and South Carolina, and who have fished for the mossbunker farther north, that none of that species

are found south of Cape Hatteras. I may mention that only one instance of the mossbunker being taken here has come under my observation.

2. Other fish are abundant here, but have diminished in numbers within the past twenty years, and I desire to respectfully call your attention to the probable cause. It is a well-known fact that brook trout will not remain in creeks below lumber-mills if the sawdust is thrown into them, for the sawdust, it is supposed, gets into their gills. The same reason would account for fish of all kinds being less plentiful now along the coast of Georgia than heretofore, as there is an immense amount of lumber sawed; and in most cases the sawdust is put in the water.

17. In November, north of Hatteras, in a body.

18. Supposed to go east to the Gulf Stream.

19. Possibly along the edge of the Gulf Stream.

20. Probably animalculæ, as their mouth seems formed for straining water.

34. For other fish, cast-nets are used.

35. Length, 6 feet; spread, 12 feet.

I beg to be allowed to add that a species of shell-fish called *prawn* (or shrimp of large growth) is very abundant on this coast during the months of March, April, and May. The length of body, after the outside shell is taken off, is from 4 to 6 inches. They are considered a great delicacy, and may be canned by a very simple process and made an article of commerce.

There is also a small fish found here in great abundance at all seasons of the year, called *finger-mullet*, a very sweet fish. There is reason to believe that this fish would rival the sardine if canned in the same or a similar manner. Its length is from 5 to 6 inches.

SAINT MARY'S, GA., *January 28, 1875.*

SIR: I have the honor to acknowledge the receipt of your circular of the 23d ultimo, relative to statistics of fisheries, and to reply that since my last communication I have learned from one of the Saint Andrew's, Ga., bar pilots that schools of fish called menhaden come into that sound with the flood-tide and go out with the ebb from the month of April until October, but not in as great numbers as found at the North. The same fish are also seen in calm weather during the winter months outside the sea islands in about seven fathoms of water in large schools from 3 to 4 feet below the surface. My informant says he has caught them at such times with snatch-hooks.

Very respectfully,

JOSEPH SHEPARD.

Hon. SPENCER F. BAIRD,

Commissioner of Fish and Fisheries, Washington, D. C

76. *Statement of J. F. Hall, Brunswick, Ga., April 11, 1876.*

First. They do not frequent the coast in this latitude.

Second. There have been a few schools seen off this coast. One was in Saint Andrew's Sound, latitude $31^{\circ} 3'$, in the spring of 1871. I saw one myself on May 30, 1872, latitude $31^{\circ} 15'$, in about eight fathoms of water. One school was reported off the coast by pilots in the summer of 1874.

77. *Statement of Capt. David Kemps, New Berlin, Fla., February 10, 1875.*

1. Bony fish.

2. Greater.

3. Increased very much.

6. Come in the river about December in large schools about the full of the moon; more numerous at that time than any other, and continue until May.

7. Swim high and low at times, and make a ripple and attract sea-gulls.

8. Not known. No one has made it a study.

9. Regular, and seem to increase both in size and number.

11. More numerous on the flow of the tide.

12. Near the mouth of the river.

13. All depths; they have been caught as low as 17 feet.

14. Not in the least.

16. The young fish leave the river from July to October, and then in solid bodies mix with young shad.

19. In the river, within 30 miles of its mouth.

20. Supposed to live on small animal-matter in the water.

21. They certainly spawn within the limit of 30 miles from the bar, as they are never seen higher up. They are supposed to spawn in the creeks and coves of the river, as they are alive with the young in the summer and fall of the year.

22. They are mixed indiscriminately

23. Has never been noticed.

24. No particular temperature.

28. Yes; in the creeks and coves of the river.

29 Yes; late in the season, say about April.

30. Catfish, garfish, crabs, eels, trout, and other fish.

31. At times we find a few fish with fish-lice in their mouth.

32. Sharks, jew-fish, porpoise, bass, and catfish are their greatest enemies, to both old and young, and they destroy a great many.

33. Yes; about four years ago they died in great numbers and were washed upon the shore of the river.

34. No particular nets are used. What are caught are in shad-nets having a 5 inch mesh. They are about 17 feet deep and all lengths.

There are about fifty nets on the river. I suppose during the season they will catch about five hundred bushels. They are a nuisance to the shad fishermen.

36. None employed.

39. Yes, more, in shad-nets, on flood-tide toward high water.

40. More numerous with northeast wind.

41. None.

42. What few are caught are used for manure.

43. None.

I will here state that these fish have steadily increased in size and numbers for the past five years. They are supposed to be much more plentiful on the coast outside of the bar.

78. Statement of Charles Koch, Jacksonville, Fla., January 15, 1874.

1. Yellow-tail.

2. In the waters of the Saint Mary's, Amelia, Bell River, and Cumberland Sound in greater numbers than other fish.

3. Increased.

5. No.

6. In February the yellow-tail appear in large schools.

7. They swim high in water only about 2 or 3 feet deep, and are only known by their capture and by the movements of sea-birds.

8. From the Atlantic Ocean, and they return by the ebb to the ocean.

9. Regular.

10. No nets are used; they are caught by hundreds with hook and line.

11. They come with the tide, and return to the ocean with the ebb.

12. Oysterbanks and sandy ground, in clear water.

13. From 3 to 5 feet; as much as 12 feet from the surface.

14. In water from 60 degrees and upward the fish are more solid and fat.

15. Appear on the breeding-grounds in companies, and are of every size and age.

16. Young fish are seen and caught from 4 to 9 inches long.

17. Leave the coast in September by degrees.

20. Small shrimp, sandbäre, and barnacles.

21. In the small creeks from March to the end of April.

22. I find that these fish go in pairs.

23. Yes.

24. Sixty to 75 degrees.

25. One to 2 feet near the bottom.

26. The eggs sink to the bottom, and become attached to oysterbeds, stones, grass, &c.

28. The young fish are found in abundance in the small creeks.

29. Yes.
 30. Wild ducks, crabs, and barnacles destroy spawn and young fish.
 31. Worms and lampreys are often found attached to the outside and on the gills; in few cases in the mouth.
 32. Sharks and salt-water catfish attack these fish.
 33. No.
 34. They have been captured in nets by accident, but the fishermen here only fish for finer kinds of fish.
 35. Nets for catching other fish are from 100 to 200 yards long and 10 feet deep.
 36. None.
 39. Yes; on the morning tide.
 40. Yes; north and west wind have effect on them.
 42. These fish are used as bait and as food for hogs and chickens, or as manure.
 43. None:
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79. *Statement of D. P. Kane, Matagorda, Tex., March 1, 1874.*

Capt. William Nichols, a pilot residing at Saluria, Tex., informs me that in September, 1872, great quantities of pogies drifted upon the beach at Saluria, and that the waters of the Gulf of Mexico and Matagorda Bay were full of them; he did not observe whether they were fat or not.

I have been engaged in pogy fishing in Maine for eight years; have fished from Florida to Mexico, but have never seen or heard of menhaden ever being south of Cape Hatteras, with the above exception.

APPENDIX O.

MISCELLANEOUS ITEMS REGARDING THE USE OF FISH FOR MANURE.

1. *The earliest printed account of the use of menhaden for a fertilizer, being an extract from an article by Ezra L'Hommedieu, 1801.*

Experiments made by using the fish called menhaden, or mossbunkers, as a manure have succeeded beyond expectation, and will likely become a source of wealth to farmers living on such parts of the sea-coasts where they can be taken with ease and in great abundance. These fish abound with oil and blood more than any other kind of their size. They are not used for food, except by negroes, in the English West India Islands; and the price is so low that it will not answer to cure them for market. They are easily taken in the month of June, when they come near the shores in large and numerous schools. These fish have been used as a manure in divers ways and on different soils.

1st. In dunging corn in the holes, put two in a hill in any kind of soil where corn will grow, and you will have a good crop. The Indians on the sea-coasts used to dung their corn with wilks and other shell-fish, and with fish if they could get it.

2d. By spreading those fish on the ground for grass a good crop is produced; put them on a piece of poor loamy land, at the distance of 15 inches from each other on the turf, exposed to the sun and air, and by their putrefaction they so enrich the land that you may mow about two tons per acre. How long this manure will last experience has not yet determined.

3d. An experiment was made the last summer by one of my near neighbors, Mr. Jonathan Tuthill, in raising vegetables with this fish-manure. About the first of June he carted near half an ox-cart load of those fish on 20 feet square of poor light land, being loam mixed with sand. The fish he spread as equally as he could by throwing them out of the cart. Being exposed to the weather they were soon consumed. He then raked off the bones to prevent their hurting the feet of the children who might go into the garden, and plowed up the piece and planted it with cucumbers and a few cabbages. The season was extremely dry, and but very few cucumbers were raised in the neighborhood except what grew on this small piece of ground, and here the production exceeded anything that had been known. By his own computation, and that of his neighbors, this 20 feet square of ground produced more than forty bushels of cucumbers, besides some fine cabbages. I measured the ground myself, and make no doubt of the quantity adjudged to have grown on the same.

By putting these fish on the land for manure, exposed to the air until they are consumed, there can be no doubt that a considerable part of the manure is lost by the effluvia which passes off the putrefied substance, as is evident from the next experiment.

4th. Mr. Joseph Glover, a farmer in Suffolk County, having a small poor farm, for a few years past has gone into the practice of making manure with these fish for the purpose of enriching his land, which is a loamy soil, dry, and in parts light. He first carts earth and makes a bed of such circumference as will admit of being nine inches thick; he then puts on one load of fish, then covers this load with four loads of common earth; but if he can get rich dirt he then covers it with six loads, and in that manner makes of fish and earth a heap of about thirty loads. The whole mass soon becomes impregnated and turns black. By experience he finds that fifteen ox-cart loads of this manure is a sufficient dressing for one acre of his poor land, which produces him thirty bushels of the best wheat by the acre, and the next year from the same land sown with clover-seed he has cut four tons of hay, which he computes at two loads and a half by the acre. The expense of making this manure where the fish are plenty cannot exceed three shillings per ton, and is the cheapest manure, considering its quality, of any yet known,

provided it is durable, which cannot yet be determined. On some parts of Long Island those fish are taken in seines, and carted six and seven miles for the purpose of manure, and is found to be very profitable business.

Mr. Glover relates a circumstance which is curious, and confirms some experiments made by Dr. Priestly, and at the same time shows that you derive less benefit from those fish when exposed to the air than when covered with earth. He made a heap composed of those fish and earth in the manner above related, near a fence where a field of wheat was growing on the opposite side. The wheat near the heap soon changed its color and grew luxuriant; and at harvest yielded nearly double the quantity of the other part of the field. He is confident that the wheat could derive no nourishment from the heap or compost by its being washed by rains to the ground on the other side of the fence where the wheat grew, and could be affected only by the effluvia arising from the putrefaction of the fish and absorbed by the leaves of the wheat.*

2. *Letters from Prof. C. A. Goessmann, on the agricultural value of menhaden fertilizers.*

AMHERST, MASS., October 6, 1877.

DEAR SIR: In answer to your favor of the 2d inst., requesting me to state whether my views regarding the character and the agricultural value of the menhaden fish-fertilizers are fully expressed in my official reports, I take pleasure to reply that my third annual report, which is published in the twenty-third annual report of the secretary of the Massachusetts State Board of Agriculture (1875 to 1876), contains the most detailed exposition of my opinions regarding that subject. Well-prepared fish-refuse from our menhaden fish-rendering works are justly considered equal to the best branch of our home manufactured nitrogenous phosphates in commercial and agricultural value. Fish-fertilizers repair to some extent the injury which agriculture suffers from the customary wasteful sewage system of our large cities; to secure an increased supply is worthy of the most careful consideration from an economical stand-point. The due appreciation of our fish-fertilizers suffers still from their variable composition; they differ quite frequently largely in moisture, and are, as a general rule, too coarse to secure speedy action. A more uniform mode of rendering and a more satisfactory mode of drying and grinding are very desirable for obvious reasons. To separate the rendering business from the manufacture of the fertilizers promises better chances for the removal of the present difficulties. I am informed that a patent has been secured to abstract the fat more thoroughly by some chemical process—I presume by means of bisulphide of

* Communications made to the society, relative to manures, by Ezra L'Hommedieu, esq. < Transactions of the Society for the Promotion of Agriculture, Arts, and Manufactures, instituted in the State of New York. Vol. I, 1801, pp. 65-67.

carbon or benzine—yet I cannot vouch for the correctness of that statement; to render but slightly the fish mass and to abstract the remainder of the fat subsequently with some suitable liquid, benzine, &c., would be a step in the right direction. I found 18 per cent. of fat in dried fish-scrap; a good Norwegian fish-guano contains frequently but from 2.5 to 3 per cent. of fat, and is ground to a fine powder. The entire removal of the fat favors the drying of the fish mass and increases its percentage of nitrogen and phosphoric acid, which in turn raises the commercial value of the resulting material. The feeding of the fish-guano as a rich article of food to our domesticated herbivorous animals, as sheep, &c., has engaged of later years considerable attention on the part of scientific investigators as a more economical mode of using fish for fertilizing purposes. The German experiment stations at Proskau and at Hohenheim have published of late interesting confirmatory results. I take the liberty to inclose a page of printed matter, which contains a fair statement of present values of fertilizing substances; it is taken out of my fourth annual report on “commercial fertilizers,” and may prove of interest to you. Offering my services most cheerfully in case my opinion on any particular point should be desirable, I remain

Very respectfully, yours,

C. A. GOESSMANN.

Prof. G. BROWN GOODE,

Washington, D. C.

AMHERST, MASS., *November 24, 1877.*

DEAR SIR: I sent to day by mail such of my reports as are still on hand. I regret that I have no copy of my third report, which contains the most detailed discussion on fish and fish fertilizers. I presume by writing to Hon. Charles L. Flint, secretary of the Massachusetts State Board of Agriculture, Boston, for his annual report of 1875 to 1876, which contains my third report, you may be able to secure a copy. A carefully dried and finely ground fish is considered to be one of our best substitutes for the Peruvian guano, which is formed from the excretions of fish-eating animals, as sea-birds, &c. To secure a similar speedy influence on the growth of plants, it is customary to compost fish with soil in the usual manner a month or two previous to the designed use. The flesh of fish coming from the rendering vats is in an excellent condition for rapid disintegration; the same may be said regarding the fish-bones. An addition of sulphuric acid to fresh fish-refuse from the oil-press exerts a beneficial influence on the gradual disintegration of the organic matter and the bones, securing at the same time the entire amount of nitrogen by rendering the ammonia formed non-volatile. Larger quantities of sulphuric acid produce an increased amount of soluble phosphoric acid. A good fish-guano belongs to our richest nitrogenous materials for manuring purposes. An addition of soluble phosphates in many in-

stances aids in economizing its nitrogen, and thereby lessens the expenses for the production of many of our farm crops. Potash compounds added to fish-guano tend to produce a more complete fertilizer, and therefore renders its use safer wherever larger proportions of potash compounds are essential for the crops under cultivation. Fish-guano, like Peruvian guano, is very deficient in potassa. To render the fish before working them into fertilizers is not only good economy as far as the gain of the oil is concerned, it favors also a more rapid disintegration of the organic matter by allowing the moisture freely to permeate the entire mass. The more the fat has been removed previous to their incorporation into the soil, the more speedy will be their disintegration and subsequent diffusion in the soil. Oil appears also to be indifferent to plant-growth.

Wishing that these short discussions of your special inquiries may be not without interest to you, I remain

Respectfully, yours,

C. A. GOESSMANN.

Prof. G. B. GOODE,
Middletown, Conn.

3. *A Description of the factory of the Pacific Guano Company, at Wood's Holl, Mass.*

Menhaden scrap is used to a considerable extent for the purpose of securing the desired proportion of nitrogen (ammonia) in the manufacture of those commercial fertilizers known as superphosphates. By many manufacturers it is used only incidentally, their chief reliance being bird-guano or the dried refuse of the slaughter-houses. The Pacific Guano Company of Boston, however, make it their base for ammonia, and use it as a principal ingredient of their manufactured guano. This company was established in 1861 by a number of ship-owners in search of business for their unemployed vessels. Having purchased Howland's Island in the Southern Pacific, where there was a rich deposit of bird-guano, they established their business on Spectacle Island, in Boston Harbor, and here they carried their guano, and, having dried it in the vats of the deserted salt-works, put it up in bags for the market. After a time it was suggested that the guano might be improved by the admixture of refuse fish, and that the ammonia lost by exposure to the weather might thus be replaced. In this way the use of menhaden chum, already well known as a manure, was introduced into the manufacture.

In 1863 the works were removed to Wood's Holl, Barnstable County, Massachusetts, with the intention of capturing the fish needed, and after extracting the oil, applying the pumice to the manufacture of guano.

To this end an extensive outfit of vessels and nets was obtained and a force of men employed. The location, however, proved to be unfavorable, and after five years' trial the fishery project was abandoned. At this point, however, there was little difficulty in procuring the necessary supply of fish-scrap from the oil-works on Narragansett Bay and Long Island Sound.

About 1866 the supply of guano on Howland's Island having become nearly exhausted, its place was gradually supplied by the phosphate of lime brought from Swan Island, and two years later by the South Carolina phosphates.

The use of the bird-guano, from which the company originally took its name, has been entirely discontinued, though for some years it was the custom to add a small percentage of that substance. The mineral phosphates are found to supply its place very satisfactorily.

The company has two factories: that at Wood's Holl and another near Charleston, S. C. The capacity of the latter is about two-thirds of the former, although the working force is about the same. That at Wood's Hole, which may be considered a representative establishment, is situated on Long Neck, about half a mile northwest of the village. The factory buildings are very extensive, covering nearly two acres of land, and are used exclusively in the manufacture of the guano, and sulphuric acid used in its development, and for storing the raw materials.

A gang of about 85 men is employed, one-third of whom are engaged in loading and unloading wharf-work, one-third in manufacture, and one-third in packing for shipment. At one time as many as 125 men were employed, but the introduction of labor-saving machinery has rendered a considerable reduction of the force practicable, while at the same time the working capacity of the factory has been largely increased.

A steam-engine of 120 horse-power is used; also two small hoisting-engines for loading and discharging cargoes. The ingredients of manufacture are few and simple, viz: fish-scrap, mineral phosphate of lime, sulphuric acid, and incidentally kaiuit, and sometimes common salt.

The average annual purchase of scrap amounts to not far from 10,000 tons. It is stored in bulk in great wooden sheds, and is sometimes retained a long time before it can be used. At the time of writing, August 16, 1875, a large quantity remains over from the previous year. The store-houses cover an area of 16,640 square feet, and the scrap is stowed to the depth of 15 feet, giving a storage space of 159,600 cubic feet.*

The mineral phosphate is obtained chiefly from South Carolina, from

* In a letter of October 8, 1877, Mr. A. F. Crowell states: "In our business here we consumed for the year 1875-'76, 708 tons dry scrap (menhaden), value \$29,164; 2,338 tons crude scrap, value \$31,682; producing 13,010 tons soluble Pacific guano; 1876-'77, 2,176 tons dry scrap, value \$57,784; 5,188 tons crude scrap, value \$32,248; producing 11,398 tons soluble Pacific guano. Our works at Charleston usually consume one-third less than here."

the Ashley and Cooper Rivers and from Chisholm's Island in Bull River, near Saint Helena Sound. The company owns Swan Island, situated in the Caribbean Sea, about 290 miles off Jamaica, and the phosphate of lime was obtained from that point until 1866 or 1867, when the reopening of the south gave access to the Charleston beds. The company of late has used a considerable quantity of the rock from Navassa, a small island lying between Cuba and Santo Domingo, a reddish deposit, rich in phosphate of lime. This deposit is estimated to contain on the average 72 per cent. of phosphate of lime, while the brown deposit from Saint Helena Sound, technically known as "marsh-rock," contains 60 per cent., and the yellow "land-rock," from the vicinity of Charleston, only 50. About 12,000 tons of this rock is used annually in the Woods Holl establishment. Great piles of rock are to be seen lying out of doors and under sheds, and at the time of my visit it was estimated that there were seven or eight hundred tons on hand. The only damage to which it is liable from exposure is that it collects moisture and becomes more difficult to grind. In such cases it is piled in great heaps upon a brick floor, and roughly kiln-dried by a fire of soft coal kindled under it.

The sulphuric acid used is manufactured on the spot from Sicily sulphur, which is brought in vessels from Boston and direct from the Mediterranean. About 1,200 tons of sulphur are used annually, and not far from 3,000 tons of sulphuric acid. The sulphuric acid used in manufacture is brought up to a standard density indicated by 66 on the Baumé hydrometer, a specific gravity of 1.7674.

The buildings used in this branch of the business are nearly as extensive as all the others. The three leaden tanks have a capacity of 185,000 cubic feet, the smaller containing 48,000 the others 2,000 and 6,500 respectively.

In the early days of the business the sulphuric acid was brought from Waltham, Mass., and New Haven, Conn., in carboys, but since 1866 it has been manufactured in Woods Holl at a large saving of expense. The Leopoldshall kainit, which averages about $12\frac{1}{2}$ per cent. potash, comes from the mines at Leopoldshall, in the Duchy of Anhalt, near Stassfurt, in Germany. Its use is comparatively recent, until this year it having been impracticable to obtain it in any considerable quantity. At the time of my visit a Hamburg brig was discharging a cargo at the wharf. Not far from 500 tons are used annually. It takes the place of the coarse salt formerly used, a refuse product from the gunpowder works at New Haven, Conn.

The process of manufacture is sufficiently simple. The fish-scrap, on its reception, is stored, after being mixed with about 3 per cent. of its weight of kainite. This is a precaution necessary to prevent fermentation and putrefaction. Experiments are now in progress to test the effect of a large mixture of kainite, which it is hoped will do away entirely with this trouble. Common salt, as has been stated, was formerly used for this purpose.

The phosphate, as needed, is crushed in a stone-crushing machine, and ground between millstones to the consistency of fine flour. A convenient arrangement of hoppers and elevators greatly facilitates this part of the work.

The scrap having been stored in one wing of the factory, the ground phosphate in another, the sulphuric acid having been forced into a reservoir near by, by pneumatic pressure, the process of mixing is easily carried on. For this work, two of Poole & Hunt's patent mixers are employed. These are larger basins of iron, each of which contains about a ton of the mixed material. In these the ingredients are placed in the proportion of 1,000 pounds of phosphate, 900 of scrap, and from 300 to 450 pounds of sulphuric acid. The basins then revolve rapidly, while a series of plows on one side, also revolving, thoroughly stir the mass which passes under them. Fifteen minutes suffices for a thorough mixture, and the guano is removed to a storage-shed, where it remains for six weeks or more to allow the ingredients to thoroughly combine. It is then thrown into hoppers, passed through rapidly-revolving wire screens, and after it has been packed in 200-pound sacks is ready for the market. About 600 bags can be filled in a day.

Before the invention of the Poole & Hunt mixing machine the guano was mixed with hoes in large wooden or stone tubs. This process was laborious and very expensive, and various machines were devised, but they proved failures because the materials caked, clogging the wheels and knives in a very short time.

The guano often contains hard lumps such as cannot be pulverized by the wire screen. Residue of this kind is subjected to the action of the Carr disintegrator, which consists of two wheels revolving in opposite directions at the rate of 600 revolutions to the minute.*

The offensive odor of the factories renders them disagreeable to persons residing in the neighborhood, and legal measures have been taken in one or two instances to prevent the manufacturers from carrying on their business, May 5, 1871, at the session of the United States circuit court in New Haven, Judge Woodruff, Connecticut *vs.* Enoch Coe, of Brooklyn, N. Y., granting an injunction to restrain the defendant from manufacturing manure from fish at his works in Norwalk Harbor, on the ground that the same created a nuisance. In 1872 the Shelter Island Camp-meeting Association made an effort to have the factories on Shelter Island closed, on the same grounds. People interested in building up Woods Holl as a watering place once agitated legal measures to compel a removal of the works, but the general sentiment of the town of Falmouth, in which the company pays heavy taxes, and specially of the many villagers of Woods Holl who earn their living in the works, prevented any results.

* The above description was written up in 1874 from facts contributed by Messrs. Crowell and Shiverick, of the Pacific Guano Company, and short-hand notes taken by Mr. H. A. Gill.—G. B. G.

4. *The Cumberland Bone Company's works.*

The following account of a similar establishment in Maine is taken bodily from the report of Boardman & Atkins. The facts appear to have been compiled from an article in the Lewiston Evening Journal, for August 17, 1874.

"The Cumberland Bone Company, whose works are located in Booth Bay, is more largely engaged in the use of fish-scrap in the manufacture of commercial fertilizers than any other company operating in this State. The works of this company, formerly located in Cumberland County, were removed to Booth Bay in 1873-'74, and altogether occupy six buildings for the various purposes connected with their business. They use South Carolina phosphatic rock, Nevassa, ground bones, fish, scrap, sulphuric acid, salt cake, and a slight amount of deodorizing compound. The phosphatic rock is heavy and solid, of a grayish color, in lumps of all sizes, and is bought by the cargo. The Nevassa is reddish brown in color, quite fine, a little lumpy, but not at all solid, and is a sort of guano from an island of the same name in the West Indies. These two are ground together in the proportion of two parts of the former to one of the latter; being ground to a fine powder which is of a grayish cinnamon-brown color. The fish-scrap used by the company is furnished by the Atlantic Oil Works, whose establishment is situated very near the works of the former company. Before being used it is treated with the deodorizing mixture—a substance of a very faint yellow color, of which, judging from its appearance, one would say that gypsum might be the foundation. This mixture is made in one of the buildings of the company provided with a furnace and the necessary tanks or retorts, and its preparation is a secret process, understood to have been invented by the president of the company. It is said to have been thoroughly tested and to work well, and it is thought will come into use generally among the companies that handle fish-scrap. At present a good many of them are troubled with injunctions because of the steuch arising from the accumulated scrap, which is constantly giving off its ammonia. After being treated with this deodorizer the scrap is placed in barrels, and is quite inoffensive, a slight odor of ammonia being observable. Bones are ground raw; to get them fine enough they go through several mills, but they are not reduced near so fine as the phosphatic rock or Nevassa. The company sell large quantities of this bone meal as feed. One of the buildings of the company is used for the manufacture of sulphuric acid, of which sulphur and niter are the principal ingredients. Salt cake is a residue from the distillation of niter as carried on in the acid works. The mixing of the ingredients into superphosphate is performed in the mixing-room, an apartment of the main manufacturing building. Over a circular floor, about eight feet in diameter, revolve horizontally several arms with breaks and scoops attached. Ingredients are poured upon the floor, the arms revolve, dense fumes

arise from the chemical action, and in a very short space of time the process is complete. The arms stir the mixture together perfectly and collect it in the middle of the table, whence it is dumped into the basement. Here it is piled up, and as soon as convenient it is passed through a long cylinder, where it is dried by hot air. It is then passed through a long series of revolving sieves, and all the coarser particles, which consist altogether of pieces of fish, are dried and ground over again. The superphosphate is then barreled. It is a very dark gray, almost black in some specimens, but drying off to a light gray. In some lots there is a brownish tinge. In mechanical texture the superphosphate in the barrels is not perfectly fine—a great quantity of bits of fish remaining unchanged in it. The proportion of the different ingredients used in the manufacture of superphosphate at these works cannot be stated, and is probably one of the secrets of the business. A gentleman who has furnished much information for this paper says that “one ton of fish scrap furnished the ammonia for three tons of superphosphate; the larger portion of the other ingredients being Nevassa, which costs about \$14 per ton, and gypsum, which costs 75 cents per ton.” The capital stock of this company is \$200,000, and it gives employment to about fifty men. It made in 1874, 10,000 tons of commercial fertilizer, valued at \$450,000. The works are regarded as the most complete of the kind in the country, are provided with a seventy-five-horse-power engine, and with extensive fixtures for the manufacture of sulphuric acid, which when in operation will make six tons of acid per day. The entire cost of the buildings and machinery was \$110,000. It is obvious that these works were located here with good reason. One sees a car moved by steam ascending from the pogy-oil factory loaded with chum. It passes upon scales, is weighed and then moves on over an immense bin into which it is dumped. A chemical mixture is added to the heap to prevent the escape of ammonia and to kill the offensive effluvia.”—[Boardman & Atkins, *op. cit.*, pp. 38-40.

5. *The Quinnipiac Fertilizer Company's Works.*

The Quinnipiac Fertilizer Company of New Haven was established in 1852, by William D. Hall, of Wallingford, Conn.; and is the oldest establishment of its kind in the United States. It was founded under Mr. Hall's patent for drying fish scrap by solar heat. Scrap was purchased from the oil manufacturers of Maine and Long Island, and, having been prepared for agricultural purposes, was sold to the Connecticut farmers for thirty cents a bushel. This fertilizer was not essentially different from that now sold by the same company as “dry-ground scrap.” In 1854 the manufactory was removed from Wallingford to the banks of the Poquannock River, in Groton, and the company began buying fish and making oil. In 1857 it was again removed to Pine Island, where

the buildings now occupied by the company were put up. From that time their business has steadily increased. In 1871 the company began, in connection with their other enterprises, the manufacture of superphosphates; this was done for the purpose of using the fish scrap immediately after the oil had been expressed, thus avoiding that loss of ammonia which takes place when the pomace is allowed to ferment. They still continue the process of solar drying on platforms, finding that it is more profitable to prepare in large quantities in this manner, at the same time using what is necessary in the manufacture of superphosphates. They have tried several machines for artificial drying, but have not found any which are sufficiently capacious to be profitably employed.

In the manufacture of their superphosphate they use dried and fresh fish-scrap, Nevassa phosphates, pulverized bone, kainit, and sulphuric acid.

They produce annually about 2,000 tons of superphosphates and 3,000 to 4,000 tons of other fertilizers, which are widely distributed through the New England and Southern States, and are also sent to the West Indies, Santa Cruz, Porto Rico, Cuba, and the Bermudas.

Their manufactured products are classed by four grades: (1) Pine Island Superphosphate, containing from 4 to 5 per cent. of ammonia, 7 to 9 per cent. of phosphoric acid (average), and 2 per cent. of potash; (2) Pine Island Guano, containing 7 per cent. of ammonia and 7 of phosphoric acid, which is intended chiefly for tobacco farmers and market-gardeners; (3) Quinipiac dry-ground fish guano, which is sun-dried scrap thoroughly ground; and (4) crude or half-dried scrap.*

6. *The Crowell Chemical Manufacturing Company.*

A NEW INDUSTRY.—The Crowell Chemical Manufacturing Company, at Woods Holl, are now building a large factory that is nearly completed for the purpose of making fish flour for the European markets, this flour being a dry, inodorous poudrette for agricultural purposes.

As soon as the building is completed a large amount of machinery that is ready for the purpose will be placed in order immediately, and then the company will be ready to commence operations.

They will require twenty tons of fish each day to supply their needs, and as the whole fish is utilized by their process they desire large ones for their business, the bodies being valued in the following order: Black-fish, porpoises, sharks, dog-fish, porgies, and skates, the fish being bought entirely by weight.

Sharks will be purchased at about the same rates as porgies, as will dog-fish. The company will employ from one to three steamers to con-

* These facts were given us by Mr. H. L. Dudley, president of the company, during a visit to Pine Island in October, 1877.—G. B. G.

stantly cruise for their supplies, making trips from Block Island to the coast of Maine, touching at Noman's Land, Martha's Vineyard, Nantucket, Cape Cod, and other intermediate points, to see the fishermen and purchase their catches.

Dr. Sims, the head of this business, was the medical director of the Third Army Corps at the close of the rebellion, to which he was appointed after serving a year as surgeon on the staff of General Hooker, and is a gentleman of great business capacity and superior intelligence.—[Island Review.

"PACIFIC GUANO COMPANY,
"Woods Holl, Mass., October 8, 1877.

"DEAR SIR: Yours 2d at hand. An improved process for the treatment of fish is now being tested by myself and others. Experiments reveal to us that the fish can be preserved, and that we are able to get a scrap from them of higher grade in ammonia and a dry powder. The fish are treated with bisulphide of carbon and of hydrocarbons as benzine. The process removes all the oil and leaves the product in a dry powder. The by-product of oil is about eighty per cent. more than by kettle and press, and goes far towards paying expenses.

"The dry scrap as now obtained from menhaden yields on an average, 10.50 per cent. ammonia (NH_2); by the new process 14 per cent. ammonia (NH_3).

"We are erecting a building 85 by 40 feet, 34 feet high, to fully test the process, and expect to be in working order in December. I inclose an article taken from the Nantucket paper. You can no doubt give us valuable information in regard to the habits of the shark, their breeding-ground, &c. The fishermen represent a supply off Nantucket that can be taken with hook and line.

"In our business here we consumed for the year 1875-'76 708 tons dry scrap (menhaden), value \$20,164; 2,338 tons crude scrap, value \$31,682; producing 13,010 tons soluble Pacific guano; 1876-'77, 2,176 tons dry scrap, value \$57,784; 5,188 tons crude scrap, value \$62,248; producing 11,398 tons soluble Pacific guano. Our works at Charleston usually consume one-third less than here.

"The menhaden scrap is now dried more extensively than ever. The solar heat and hard platforms found to be the cheapest and most satisfactory process. We purchase what dry scrap we can in place of crude scrap. I send you the only document published bearing on the history of this company.

"Yours, truly,

"A. F. CROWELL.

"Prof. G. BROWN GOODE."

7. *Methods of calculating costs of valuable ingredients of fertilizers.**

The method referred to on page 235 consists in comparing different fertilizers by the costs per pound of the valuable ingredients at the prices at which the articles are sold.

The way in which these computations are made here may be explained as follows:

Take first a simple case, a sulphate of ammonia containing 20 per cent. of nitrogen, and sold at \$100 per ton. Twenty per cent. is equivalent to 400 pounds in a ton of 2,000 pounds. These 400 pounds of nitrogen cost \$100. One pound will therefore cost $\$100 \div 400 = 25$ cents.

Now, a more complicated case. Suppose a superphosphate to contain valuable ingredients (and that, for convenience, we indicate the latter by abbreviations), as below:

Soluble phosphoric acid, (Sol.)	.....10	per cent.=200 pounds in ton,
Insoluble phosphoric acid (Ins.)	..... 2.5	per cent.= 50 " " "
Nitrogen (N.)	..... 3	per cent.= 60 " " "

that it be sold at \$40 per ton, and that the values of the ingredients are in the ratios of Sol. 15, Ins. 6, and N. 25 cents per pound. The problem will be to find a series of values in the ratios 15 : 6 : 25, which, multiplied by the respective numbers of pounds of Sol., Ins., and N. in a ton, will give three products, whose sum will be \$40. The method employed here for solving the problem is as follows: The assumed rate for Ins. was 6 cents, that for Sol., 15 cents, or $2\frac{1}{2}$ times as much, and that for N. 25 cents, or $4\frac{1}{6}$ times as much. Multiply the number of pounds of Sol. in a ton by $2\frac{1}{2}$, and that of N. by $4\frac{1}{6}$, and add the products to the number of pounds of Ins., and the sum will be the number of pounds of Ins. which would have the same value as the Sol., Ins., and N. actually present taken together. Divide the whole cost by this sum and the quotient will be the cost of one pound of Ins. This multiplied by $2\frac{1}{2}$ will give the cost of one pound of Sol., and by $4\frac{1}{6}$ will give the cost of one pound of N. The calculations for the above case will be:

Sol.	.....200 pounds	$\times 2\frac{1}{2}=500$ pounds	Ins.
Ins.	..... 50 "	$\times 1 = 50$	" "
N.	..... 60 "	$\times 4\frac{1}{6}=250$	" "
			800 " "

The price per ton, \$40, divided by 800, gives 5 cents, the cost of one pound of Ins.; $5 \times 2\frac{1}{2}=12\frac{1}{2}$ cents cost, of one pound of Sol.; and $5 \times 4\frac{1}{6}=20\frac{5}{6}$, cost of one pound of N.

*From report of Connecticut Agricultural Experiment Station, 1876, W. O. Atwater, director.

The proof of the correctness of these figures is plain :

Soluble phos. acid, 200 lbs., @ $12\frac{1}{2}$ cents, would cost.....	\$25 00
Insoluble “ “ 50 lbs., @ 5 “ “ “	2 50
Nitrogen 60 lbs., @ $20\frac{5}{8}$ “ “ “	12 50

Total valuable ingredients in ton would cost \$40 00

Another method for calculating the costs of ingredients, which consists in estimating the value of one at an assumed rate per pound, subtracting its total value, as thus computed, from the whole cost, and dividing the remainder by the number of pounds of the other ingredients to get the cost of the latter, is too simple to require further explanation here.

In valuations current in this country, nitrogen in these substances has been reckoned as worth all the way from two to five times as much as phosphoric acid, pound for pound. Considering the fact that the nitrogen is generally in quite readily, and the phosphoric acid often in very slowly available forms, there is ground for varying ratios. A full discussion of this subject would require more space than either the knowledge at our disposal or the necessary limits of this article would permit. In brief, however, I do not find it easy to see why, if nitrogen is worth only about twice as much as phosphoric acid, pound for pound, when both are in their most available forms, it should be worth three or four times as much, as is sometimes assumed, in bone, in which both occur in much less available forms. Too little is known at present of the effect of decomposing nitrogenous matter in bone, fish, castor-pomace, and the like, in dissolving, diffusing, and otherwise rendering available the phosphates with which it is so intimately connected, to enable us to form any accurate estimate of its value on this account. I confess that in the light of the little knowledge that we do have it seems to me more just to preserve ratios of valuation of nitrogen and phosphoric acid in bone the same, or nearly the same, as in the most available forms. In fish, animal refuse, and other materials which contain considerable nitrogenous matter other than that so intimately mingled with the phosphate, and in a form probably more ready to decompose, it seems reasonable to give the higher relative value to nitrogen.

In view of such considerations as these, the costs of nitrogen and phosphoric acid in the tables in this report have been calculated on the basis of ratios as follows :

In fish, slaughter-house refuse, and castor-pomace—Nitrogen : Phosphoric acid :: $2\frac{1}{2}$: 1.

In bone—Nitrogen : Phosphoric acid :: 2 : 1.

In superphosphates the costs of the ingredients are calculated on a basis of ratios as per the valuations used in the last report of the station, to wit : Nitrogen, 25 ; phosphoric acid, soluble in water, 15 ; soluble in ammonium citrate, 10 ; insoluble, 6.

In Peruvian guanos the same rates are adopted as for the superphosphates, the additional ingredient potash being rated at 8.

The prices are those at which the articles have been sold, or offered to farmers during the year at the places of sale; the lower rates in large quantities, lots of a ton or more, for cash; the higher one for smaller lots, or on time.

In addition to the analyses and valuations given in the text of the report, the following are presented as indications of the actual condition of the fertilizer market in respect to three most important classes of commercial fertilizers—nitrogenous superphosphates, Peruvian guanos, and fish manures. The prices given are those which prevailed in 1875-'76, and are in some cases a trifle higher than now rule.

TABLE I.
Nitrogenous phosphates and superphosphates.

Name of fertilizer.	ANALYSES.										VALUATIONS.					
	Station number.	Moisture.	Sand, &c.	Phosphoric acid.				Potash.	Nitrogen.	Ammonia equivalent in nitrogen.	Retail price per ton.	Cost of one pound each of valuable ingredients at prices stated.				
				Available.		Insoluble.						Phosphoric acid.				
				Soluble.	Reverted.	Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.	Nitrogen.		Soluble.	Reverted.	Insoluble.	Potash.	
Dissolved Bone, Thompson & Edwards.	14	9.02	3.77	1.31	Pr. ct.	11.43	12.74	Pr. ct.	3.65	4.44	\$48 00	31.2	18.5	Cents.	8.9	Cents.
Do.	95	8.71	.....	None.	.....	12.77	12.77	.....	4.25	5.15	48 00	30.3	.....	.....	8.6	.....
Do.	107	12.37	.....	.....	.....	12.38	12.38	.....	3.99	4.84	47 50	31.5	.....	.....	9.0	.....
Dissolved Meat and Bone, Thompson & Edwards	165	13.51	.....	.....	6.67	7.41	14.08	.....	5.20	6.31	50 00	24.5	.....	10.5	7.0	.....
Ammoniated Bone Sape phosphate, Thompson & Edwards	18	13.15	0.90	.....	.....	8.31	8.31	.....	3.40	4.12	48 00	41.5	.....	.....	11.9	.....
Do.	26	14.84	.....	.....	.....	13.78	13.78	.....	4.16	5.05	48 00	29.6	.....	.....	8.4	.....
Do.	139	19.31	2.27	1.70	8.60	3.22	13.52	.....	2.99	3.62	50 00	29.0	17.2	12.4	8.3	.....
"Pure Bone"	81	7.54	.....	.....	.....	15.22	15.22	.....	5.46	6.62	45 00	22.9	.....	.....	6.5	.....
Riverside Phosphate.	30	20.16	.....	.....	.....	20.44	20.44	.....	4.18	5.07	45 00	22.4	.....	.....	6.4	.....
Ammoniated Bone Superphosphate, G. W. Miles	11	19.37	2.60	0.91	0.16	0.80	10.87	.....	2.75	3.33	48 00	26.8	15.9	11.4	7.7	.....
Do.	27	18.50	.....	4.92	.....	4.64	9.56	.....	2.98	3.62	.....	.....	.....	.....	.....	.....
Do.	79	24.15	3.40	0.28	2.61	0.91	12.80	.....	2.57	3.12	45 00	23.7	14.1	10.1	6.8	.....
Ammoniated Bone Superphosphate, Russell Coe	12	18.47	0.35	0.24	1.28	6.39	13.91	.....	1.92	2.33	42.50	26.5	15.6	11.4	7.6	.....
Do.	135	20.16	.....	12.05	0.34	0.57	12.96	.....	2.94	3.50	40 00	19.2	11.4	8.2	5.5	.....
Do.	138	21.01	.....	11.67	0.92	0.20	12.79	.....	2.24	2.71	40 00	50.7	12.3	8.9	5.9	.....
Do.	168	19.35	.....	12.53	0.46	.....	12.09	.....	2.04	2.47	45 00	23.9	13.8	9.9	.....	.....
Do.	170	22.27	.....	11.03	1.08	.....	12.13	.....	3.84	4.66	50 00	32.9	13.7	9.8	.....	.....
Ammoniated Bone Superphosphate, Preston & Sons	15	21.75	3.60	9.94	.....	4.10	14.04	.....	1.67	2.03	42.50	24.2	14.4	.....	6.9	.....
Do.	134	21.97	.....	7.86	1.32	1.78	10.96	.....	2.87	3.48	40 00	33.1	13.8	9.9	6.6	.....
Superphosphate, Bridgeport Sulphuric Acid Company	17	23.33	6.90	2.82	2.23	1.89	12.94	.....	0.88	1.06	45 00	33.9	20.2	14.5	9.5	9.7
Do.	56	9.37	8.41	3.67	.....	7.43	11.10	.....	1.14	1.38	.....	.....	.....	.....	.....	.....
Superphosphate, Lister Bros	95	19.69	.....	10.29	2.12	1.38	13.79	.....	2.65	3.21	45 00	22.3	13.3	9.5	6.4	.....
Superphosphate, Lombard & Mathewson	122	4.29	4.78	5.75	6.38	2.89	15.02	.....	2.92	3.54	50 00	25.2	15.0	10.8	7.2	.....
Superphosphate, J. O. & E. Smith	63	12.35	1.45	5.06	.....	12.84	17.90	.....	2.83	3.43	40 00	34.2	.....	.....	.....	.....
Do.	132	19.53	2.50	5.71	4.94	0.27	10.92	.....	2.67	3.24	40 00	34.2	.....	.....	6.9	.....
Superphosphate, Wilson's	133	19.70	2.62	5.84	1.19	1.04	8.07	.....	2.39	2.90	40 00	29.9	17.8	12.8	8.6	.....
Superphosphate, Stegg's	169	13.52	.....	11.22	0.44	1.75	13.41	.....	2.65	3.21	55 00	27.4	16.3	11.7	7.8	.....
Phosphatic Blood Guano, Manhattan.	20	21.56	2.20	6.75	3.40	0.71	10.86	.....	2.99	3.63	53 00	30.5	18.2	13.1	8.7	.....

Do.....	23	21.83	0.93	7.83	1.75	2.08	11.66	3.92	2.90	3.52	50.00	92.8	13.6	9.8	.....	8.7
Abattoir Guano, E. F. Coe.....	42	16.24	1.59	7.39	4.11	.....	11.50	3.32	3.32	4.02	50.00	92.8	13.6	9.8	.....	8.4
Do.....	127	17.61	1.63	8.91	1.69	1.23	11.83	3.99	3.39	4.11	50.00	92.1	13.2	9.5	6.3	.....
Ammoniated Superphosphate, E. F. Coe.....	117	19.16	1.25	10.22	2.80	1.06	14.68	.....	2.54	3.08	42.00	90.4	12.1	8.7	5.8	.....
Soluble Nitrogenous Phosphate, Quinnipiac Fertilizer Co.....	101	19.27	.....	7.24	.....	0.46	7.70	.....	4.41	5.35	40.00	93.6	13.4	.....	6.5	.....
Do.....	146	16.15	.....	8.16	3.39	2.55	14.10	.....	3.33	4.00	40.00	93.3	11.4	8.3	5.5	.....
Do.....	171	17.72	.....	7.65	2.29	1.91	11.85	.....	2.49	3.02	45.00	96.2	15.6	11.3	7.5	.....
Pine Island Guano, Quinnipiac Fertilizer Company.....	99	15.63	.....	4.95	2.32	1.93	9.20	.....	5.64	6.84	45.00	92.1	13.2	9.5	6.3	.....
Do.....	173	18.19	.....	4.93	0.96	0.84	6.73	.....	6.25	7.58	45.00	92.7	13.6	9.8	6.3	.....
Charter Oak Fertilizer.....	110	13.45	8.64	8.57	.....	9.97	17.64	4.62	1.77	2.14	.....	.....	.....	.....	.....	.....
Pacific Soluble Guano.....	116	10.29	.....	5.06	1.50	7.23	13.79	4.62	2.42	2.93	45.00	94.4	14.5	10.4	4.6	9.3
Do.....	167	21.87	.....	3.46	1.39	7.13	11.98	1.80	2.48	3.01	45.00	91.3	12.6	13.4	6.0	11.9
Sternel's Ammoniated Dissolved Bones.....	120	16.83	5.83	2.64	2.31	0.44	5.39	.....	2.09	2.53	40.00	41.9	24.9	17.9	12.0	.....
Orient Ammoniated Bone Superphosphate.....	177	17.69	.....	5.96	1.55	8.05	15.56	.....	2.02	2.45	45.00	97.6	16.4	11.8	6.6	.....
Bradley's Sea Fowl Guano.....	148	13.69	.....	5.68	1.79	5.28	12.75	.....	2.37	2.87	55.00	96.5	21.8	15.7	7.0	.....
SLAUGHTER-HOUSE PRODUCTS.																
Animal Fertilizer, Brighton Abattoir.....	153	9.92	.....	.....	.....	.....	11.90	.....	6.53	7.92	40.00	90.1	.....	.....	5.8	.....
Acidulated Animal Fertilizer, Brighton Abattoir.....	31	17.59	.....	6.37	.....	1.11	7.48	.....	5.33	6.47	40.00	91.2	12.6	.....	6.1	.....
Do.....	154	17.26	.....	7.85	0.59	.....	8.44	.....	7.60	9.22	45.00	17.9	10.7	7.7	.....	.....

TABLE II.

Peruvian guanos.

Name of fertilizer.	Station number.	ANALYSES.										VALUATIONS.									
		Moisture.	Sand, &c.	Phosphoric acid.						Ammonia equivalent to nitro- gen.	Retail price per ton.	Phosphoric acid.				Cost of one pound each of val- uable ingredients, at prices stated.					
				Available.		Total.	Potash.	Nitrogen.	Soluble in water.			Soluble in ammo- nium citrate.	Insoluble.	Nitrogen.	Soluble in water.		Soluble in ammo- nium citrate.	Insoluble.	Potash.		
				Soluble in water.	Soluble in ammo- nium citrate.																
																				Pr. ct.	Pr. ct. (%)
No. 1, Peruvian Guano—"Standard"	16	16.00		5.75	11.69	17.44	9.37	11.37	15.67	9.3	6.7	4.5	6.0								
Do	47	11.40	2.10	4.14	2.42	15.37	11.33	13.75	60.00	16.7	9.9	7.2	4.8								
Do	108	21.57		5.25	9.82	17.90	8.56	10.39	60.00	16.7	9.9	7.2	4.8								
Do	137	13.06		3.27	6.24	4.01	13.52	9.42	58.50	17.8	10.6	7.6	5.1								
Do	164	15.30		6.05	5.59	1.39	13.03	4.60	57.00	18.2	10.8	7.8	5.9								
Do	166	12.63		5.55	3.44	5.15	14.14	4.06	57.00	19.3	11.5	8.3	5.5								
Do	191	14.88		5.11	7.10	17.25	3.54	7.88	458.00	17.3	10.3	7.4	4.9								
Do	8.06		1.59	3.67	4.35	11.87	3.07	8.48	58.00	20.2	12.1	8.7	5.8								
Do	245	14.19		5.10	6.46	15.31	3.60	8.48	58.00	17.1	10.2	7.3	4.9								
Average of above eight samples																					
No. 1, Peruvian Guano—Guaranteed (Cargo A)	166	13.11	11.39	4.55	4.35	7.10	3.45	5.87	7.12	20.1	12.1	8.7	5.8								
Do	187	12.54	11.30	4.50	5.11	7.49	3.36	5.79	7.03	19.9	11.8	8.5	5.7								
No. 1, Peruvian Guano—Rectified	57	12.61	1.80	10.67	None.	12.38	2.43	9.15	11.10	17.7	10.5	8.3	5.1								
Do	136	14.90		10.02	2.82	12.84	4.34	7.82	9.49	19.5	11.6	8.3	5.1								
Peruvian Guano—"Lobos"	243	10.80		6.80	6.68	4.13	4.23	4.68	5.03	17.0	10.1	7.3	4.9								
Peruvian Guano, No. 2	244	8.23	38.60	4.01	7.81	2.12	2.67	2.60	3.16	19.8	11.8	8.5	5.7								

* Not determined. The insoluble, 11.60, includes that soluble in ammonium citrate.

Assumed price. Nos. 16 and 47 were bought in 1875.

TABLE III.
Fish manures.

Name of fertilizer.	Station number.	ANALYSES.					Retail price per ton.	COST PER POUND.	
		Moisture.	Sand, &c.	Phosphoric acid.	Nitrogen.	Ammonia equivalent to nitrogen.		Nitrogen.	Phosphoric acid.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>		<i>Cents.</i>	<i>Cents.</i>
DRY GROUND FISH.									
Ground Fish, G. W. Miles	10	18.74	7.65	8.06	9.78	9.78	\$45 00	20.2	8.1
Fish Guano, G. W. Miles	98	21.96	9.70	8.07	7.36	7.36	40 00	20.9	8.4
C. Island Guano, G. W. Miles	50	8.63	1.43	7.74	8.84	10.73			
Allen's Fertilizer.	124			6.17	8.80	10.68	40 00	17.7	7.1
Do	185	6.31		7.90	7.88	9.56	40 00	18.1	7.2
Do	100	14.61		6.67	7.86	9.11	45 00	22.1	8.8
Dry Ground Fish, Quinnipiac Fertilizer Co.	140	10.85		7.21	7.88	8.97	45 00	20.5	8.2
Do	172	13.45		7.53	7.96	9.66	45 00	19.6	7.8
Do	203	8.32		8.11	8.35	10.00	45 00		
Acidulated Fish, Quinnipiac Fertilizer Co.	222	36.53		*7.09	4.11	4.99			
DRIED FISH-SCRAP.									
"Dry Fish," Green Brothers	179	11.01		10.51	8.60	10.41	28 00	10.9	4.4
"Dried Fish"	182	9.37			8.13	9.86			
"Dry Fish"	189	11.00			7.46	9.05			
"Fish Scrap"	180	7.74			8.61	8.61			
"Dry Fish"	196	7.59			7.79	9.46			
Do	199				7.65	9.28			
HALF-DRY FISH-SCRAP.									
Fish Scrap, "Half Dry"	103	40.65		6.23	5.33	6.47	16 00	10.2	4.1
Do	131	25.10	2.52	7.49	5.49	6.66	16 00	9.4	3.8
Do	197	56.85			3.03	4.41			

* Soluble in water, 1.76 per cent.; soluble in ammonium citrate, 2.47 per cent.

8. *Improved methods of drying fish scrap.*

The Hogle patent drying machine, manufactured at the works of H. B. Bigelow, New Haven, Conn., consists of a boiler containing several iron cylinders, in which the scrap is placed after it has been taken from the press, and where it is quickly dried by steam-heat. One of these machines is said to convert a ton of scrap into dry guano in an hour's time. The guano prepared in this way brings a much higher price than the ordinary scrap. An item in the New York Herald of July 22, 1872, stated that the former would command the price of \$35 per ton, while ordinary scrap is worth \$14. Ordinary scrap contains from 5.06 to 10 per cent. of ammonia, while this contains 15.

Mr. Maddocks remarks:

"With reference to drying by artificial means, which is obviously important, no doubt is felt that the apparatus now in operation will effect the work as thoroughly as may be desired, and cheaply and quickly also, provided only the oil in the scrap be reduced as above described.

"Two companies belonging to the association have succeeded in drying the scrap in considerable quantities, notwithstanding the obstacles referred to. The scrap is passed through a slightly-inclined heated iron cylinder, 30 feet long and 4 feet in diameter, and on the passage is agitated by paddles attached to a revolving shaft, and comes out at the lower end dried to about 25 per cent. of moisture. The process will be greatly promoted in dispatch and efficiency by the application of the new oil-saving method, and the whole manufacture will then be under full control. The scrap can at once, upon withdrawal from the press, be subjected to the drying process by furnace heat, irrespective of the state of the weather, and thus the loss of oil by leakage, mentioned above, and of ammonia by decomposition, be forestalled. If the contained moisture is reduced to a per cent. no lower even than 20 or 25, the scrap can be kept on the spot at convenience, and without offense to the senses, or transported as required."

In early days the fish-scrap was not dried, but was allowed to ferment in great heaps, sometimes not even protected from the weather. At the old-fashioned oil-works may still be seen these heaps of foul decaying fish, filled with maggots and flies. Salt is sometimes added; also kainit, or sulphuric acid. These arrest decay for a time, though nothing is so effective as a thorough drying process.

APPENDIX P.

EXPORTS OF MENHADEN OIL FROM THE PORT OF NEW YORK, FROM JANUARY, 1875, TO JULY, 1878.*

Date.	Quantity in bar- rels.	Vessel.	Destination.
1875.			
Jan. 9	85	Steamship Utopia	Glasgow.
14	100	Steamship State of Nevada	Do.
27	40	Steamship State of Indiana	Do.
Feb. 16	14	Steamship State of Georgia	Do.
26	100	Bark H. L. Routh	London.
Apr. 3	64	Steamship Great Western	Bristol.
9	25	Steamship State of Louisiana	Glasgow.
9	75	Steamship Bolivia	Do.
10	50	Steamship Celtic	Liverpool.
15	50	Steamship Italy	London.
May 1	120	Steamship Cornwall	Bristol.
1	250	Steamship France	Havre.
4	50	Steamship Manhattan	Liverpool.
6	190	Steamship State of Georgia	Glasgow.
21	200	Steamship State of Louisiana	Do.
22	200	Steamship Ethiopia	Do.
26	1,500	Bark G. E. Cann	Havre.
29	5	Steamship Britannic	Liverpool.
June 5	80	Steamship Arragon	Bristol.
12	75	Steamship Percire	Havre.
16	20	Steamship State of Georgia	Glasgow.
19	66	Steamship Cornwall	Bristol.
July 2	545	Steamship Italia	Glasgow.
2	82	Steamship State of Louisiana	Do.
3	478	Steamship Ethiopia	Do.
8	123	Steamship Somerset	Bristol.
9	100	Steamship Ville de Paris	Havre.
10	40	Steamship The Queen	Liverpool.
15	35	Steamship State of Indiana	Glasgow.
17	182	Steamship Elysia	Do.
23	62	Steamship Amerique	Havre.
24	169	Steamship California	Glasgow.
29	265	Steamship State of Georgia	Do.
31	135	Steamship Victoria	Do.
Aug. 3	270	Steamship Nevada	Liverpool.
6	10	Steamship Percire	Havre.
6	420	Steamship Cornwall	Bristol.
12	100	Steamship State of Pennsylvania	Glasgow.
14	432	Steamship Great Western	Bristol.
19	5	Steamship Gellert	Hamburg.
20	150	Steamship France	Havre.
21	421	Steamship Bolivia	Glasgow.
21	211	Steamship Somerset	Bristol.
26	307	Steamship State of Indiana	Glasgow.
28	170	Steamship Elysia	Do.
31	50	Steamship Idaho	Liverpool.
Sept. 2	165	Steamship State of Virginia	Glasgow.
3	200	Steamship Ville de Paris	Havre.
4	592	Steamship Assyria	Glasgow.
4	700	Steamship California	Do.
4	185	Steamship Arragon	Bristol.
6	70	Steamship Montana	Liverpool.
6	150	Steamship Britannic	Do.
15	300	Steamship Olympia	Glasgow.
17	651	Steamship Utopia	Do.
22	916	Steamship State of Pennsylvania	Do.
22	2,193	Bark Floka	London.
25	159	Steamship Bolivia	Glasgow.
Oct. 1	135	Steamship France	Havre.
2	331	Steamship Ethiopia	Glasgow.
7	277	Steamship State of Virginia	Do.
15	175	Steamship Somerset	Bristol.
21	105	Steamship State of Georgia	Glasgow.
30	160	Bark Helen	Halifax.
Nov. 3	105	Steamship Arragon	Bristol.
18	50	Steamship State of Virginia	Glasgow.
Dec. 3	100	Steamship State of Indiana	Do.
4	65	Steamship Anchoria	Do.
10	60	Steamship Glenartney	London.
21	110	Ship K. Fish	Do.

* Compiled by Jasper Pryer, with William Warden, commission and shipping merchant, 88 Wall street, New York.

Exports of menhaden oil from the port of New York, &c.—Continued.

Date.	Quantity in bar- rels.	Vessel.	Destination.
*1876.			
June 1	206	Steamship State of Pennsylvania.....	Glasgow.
9	300	Steamship France.....	Havre.
14	159	Ship Jno. Bertiam.....	London.
15	60	Steamship State of Virginia.....	Glasgow.
July 5	140	Steamship Wyoming.....	Liverpool.
11	35	Steamship Cornwall.....	Bristol.
15	141	Steamship Bolivia.....	Glasgow.
27	140	Steamship State of Virginia.....	Do.
29	50	Steamship Britannic.....	Liverpool.
Aug. 1	100	Bark Arno.....	London.
8	209	Steamship Greece.....	Do.
9	140	Steamship Arragon.....	Bristol.
12	100	Steamship Germain.....	Havre.
12	184	Steamship Ethiopia.....	Glasgow.
19	500	Steamship Labrador.....	Havre.
25	100	Steamship Canada.....	Do.
26	774	Steamship Bolivia.....	Glasgow.
28	500	Bark Joshua Loring.....	Havre.
30	10	Ship Lima.....	Hamburg.
Sept. 6	210	Steamship Somerset.....	Bristol.
9	105	Steamship Anchoria.....	Glasgow.
15	106	Steamship State of Nevada.....	Do.
16	249	Steamship California.....	Do.
16	101	Steamship France.....	Havre.
22	60	Steamship State of Indiana.....	Glasgow.
30	70	Steamship Assyria.....	Bristol.
Oct. 2	46	Steamship Victoria.....	Glasgow.
3	200	Steamship Wyoming.....	Liverpool.
6	87	Steamship State of Pennsylvania.....	Glasgow.
7	5	Steamship Bolivia.....	Do.
20	41	Steamship State of Virginia.....	Do.
Nov. 24	95	Steamship Arragon.....	Bristol.
Dec. 1	107	Steamship Cornwall.....	Do.
2	22	Steamship Anchoria.....	Glasgow.
1877.			
Jan. 25	100	Bark Vincenzo Piroto.....	Bristol.
29	139	Steamship Cornwall.....	Do.
Feb. 5	65	Bark Spirito.....	Do.
16	176	Steamship Somerset.....	Do.
26	39	Steamship Anchoria.....	Glasgow.
28	113	Steamship Arragon.....	Bristol.
Mar. 3	75	Steamship California.....	Glasgow.
6	200	Bark Johanna Wilhelm.....	Havre.
15	447	Bark Prinz Frederick Carl.....	London.
17	96	Steamship Cornwall.....	Bristol.
19	152	Steamship Assyria.....	Glasgow.
20	200	Steamship Labrador.....	Havre.
24	70	Steamship Bolivia.....	Glasgow.
27	150	Steamship Dakota.....	Liverpool.
April 2	75	Steamship Somerset.....	Bristol.
5	150	Steamship State of Nevada.....	Glasgow.
14	65	Steamship California.....	Do.
21	70	Steamship Ethiopia.....	Do.
25	100	Steamship Ville de Paris.....	Havre.
May 1	500	Steamship Labrador.....	Do.
3	200	Steamship State of Pennsylvania.....	Glasgow.
5	589	Steamship Bolivia.....	Do.
7	350	Steamship Caledonia.....	Do.
9	350	Steamship Canada.....	Havre.
10	175	Steamship Scythia.....	Liverpool.
12	245	Steamship Alsatia.....	*Glasgow.
14	71	Steamship Somerset.....	Bristol.
15	100	Steamship France.....	Havre.
18	80	Steamship State of Nevada.....	Glasgow.
19	794	Steamship Anchoria.....	Do.
23	100	Steamship Pereire.....	Havre.
29	160	Ship Subra.....	London.
June 2	45	Steamship Alexandria.....	Glasgow.
2	107	Steamship Ethiopia.....	Do.
6	70	Steamship Arragon.....	Bristol.
9	35	Steamship Victoria.....	Glasgow.
12	200	Steamship Labrador.....	Havre.
14	239	Steamship State of Pennsylvania.....	Glasgow.
16	204	Steamship Bolivia.....	Do.
16	100	Ship C. H. Southard.....	London.

*There were none exported from January 1 to June 1, during 1876.

Exports of menhaden oil from the port of New York, &c.—Continued.

Date.	Quantity in bar- rels.	Vessel.	Destination.
1877.			
June 18	105	Bark John Reel	Havre.
21	147	Steamship State of Nevada	Glasgow.
23	142	Steamship Dorian	Bristol.
25	40	Steamship Devonian	Glasgow.
25	555	Ship Empire of Peace	Liverpool.
26	100	Steamship Pereire	Havre.
28	185	Steamship Cornwall	Bristol.
July 9	68	Steamship Guillermo	Do.
9	200	Ship R. J. Moulton	Havre.
9	40	Steamship Devonian	Glasgow.
11	137	Steamship Somerset	Bristol.
13	137	Ship Tewkesbury	Liverpool.
14	231	Steamship Ethiopia	Glasgow.
26	76	Steamship Suevia	Hamburg.
30	201	Steamship Devonian	Glasgow.
Aug. 3	25	Steamship Pelota	Bristol.
4	75	Steamship Utopia	London.
6	33	Steamship Caledonia	Bristol.
18	63	Steamship Scandinavian	Do.
21	135	Steamship St. Laurent	Havre.
Sept. 5	70	Steamship Labrador	Do.
11	70	Steamship Alexandria	Bristol.
14	2	Ship Crusader	Havre.
Oct. 9	75	Steamship Amerique	Do.
9	35	Steamship Cornwall	Bristol.
Dec. 29	201	Bark Enigma	London.
1878.			
Jan. 18	200	Bark Gyda	Do.
Mar. 16	300	Ship Paulino	Do.
21	300	Ship Europa	Do.
28	50	Steamship Anglia	Do.
29	50	Steamship Arragon	Bristol.
30	1	Steamship Andes	Port au Prince.
Apr. 4	1	Steamship Etna	Savanilla.
17	150	Steamship Scandanavian	Bristol.
18	91	Steamship Somerset	Do.
25	90	Ship S. E. Messinger	Havre.
25	1	Steamship Atlas	Kingston.
30	2	Bark Anisa	Savanilla.
May 1	150	Ship Favorite	London.
8	101	Steamship Anglia	Do.
13	350	Ship Alhambra	Havre.
13	40	Steamship Devonian	Glasgow.
16	85	Steamship Baltic	Liverpool.
18	75	Steamship Anchoria	Glasgow.
25	60	Steamship Adriatic	Liverpool.
28	200	Steamship Pereire	Havre.
28	200	Ship Joseph	Do.
29	27	Steamship Herder	Hamburg.
June 1	60	Steamship Britannic	Liverpool.
1	30	Steamship Castalia	Glasgow.
1	200	Ship L. L. Sturges	London.
1	175	Steamship Ethiopia	Glasgow.
1	56	do	Do.
5	1	Bark Victor	Falmouth.
5	252	Ship J. A. Stamler	Havre.
5	248	do	Do.
5	168	do	Do.
7	2	Steamship Atlas	Kingston.
12	139	Steamship St. Laurent	Havre.
12	167	do	Do.
12	6	Steamship Santiago de Cuba	Havana.
15	784	Bark H. L. Routh	Glasgow.
15	95	Steamship Germanic	Liverpool.
15	104	Steamship Lepanto	Hull.
17	56	Steamship Wyoming	Liverpool.
18	143	Steamship Labrador	Havre.
25	179	Ship Precrossa	Do.
27	50	Steamship Utopia	London.
27	626	Ship James Foster, jr	Liverpool.

NOTE.—From other ports in United States, 2,600 barrels.

APPENDIX Q.

SUPPLEMENTARY NOTES.

NOTE.—Since sending the manuscript of this report to press, several valuable contributions to the knowledge of the menhaden and the menhaden industry have been received. In order to bring the discussion of the subject up to date these have been included in an appendix, with references prefixed, which show their proper connection in the body of the report.

GLOUCESTER, MASS., *September 22, 1878*

1. *An early allusion to the fat back on the Southern coast.*

(Paragraph 28, p. 14.)

Catesby, in his *Natural History of the Carolinas, Florida, and the Bahamas, 1731–1742*, Vol. II, p. xxxiii, makes the following allusions to the “fat-back” or menhaden:

“Herrings in *March* leave the salt Waters and run up the Rivers and shallow Streams of fresh Water in such prodigious Shoals that people cast them on Shore with Shovels. A Horse passing these waters unavoidably tramples them under his Feet; their Plenty is of great Benefit to the inhabitants of many Parts of *Virginia* and *Carolina*. But the most extraordinary Inundation of Fish happens annually a little within the northern Cape of *Chesapick Bay* in *Virginia*, where there are cast on Shore usually in *March*, such incredible Numbers of Fish, that the Shore is covered with them a considerable Depth, and three Miles in length along the Shore. At these Times the Inhabitants from far within Land come down with their Carts and carry away what they want of the Fish; there remaining to rot on the Shore many Times more than sufficed them: From the Putrefaction that this causes the place has attained the Name of *Maggoty Bay*.

“These Fish are of various Kinds and Sizes, and are drove on Shore by the Pursuit of Porperes and other voracious Fish, at the general Time of Spawning; amongst the Fish that are thus drove on Shore is a small fish called a *Fat-back*; it is thick and round, resembling a Mullet but Smaller. It is an excellent Sweet Fish, and so excessive fat that Butter is never used in frying, or any other Preparation of them. At certain Seasons and Places there are infinite Numbers of these Fish caught, and are much esteemed by the Inhabitants for their Delicacy”

2. *Departure of the schools in the fall.*

(Section 12, p. 38.)

Mr. Charles G. Atkins, in a letter to Professor Baird, March 9, 1878 (Bucksport, Me.), states that young menhaden were more abundant than

ever in the fall of 1877. Sometimes at a single tide each net-fisherman would catch at his "berth" thirty or forty individuals. They continued to take them until January.

Mr. H. L. Dudley, of Pine Island, states that the season in Eastern Long Island Sound has usually opened May 1 to May 10, and closed about November 15. In 1877 some fish were caught after December 1, and in 1878 his steamer caught 125,000, April 15, the earliest catch ever known.

3. *The spawning-grounds of the menhaden.*

(Paragraph 133, p. 99.)

Evidence now tends to show that some of the schools, at least, defer spawning until the season of their approach to the coast in April. Like the mackerel, they seem to come into the shoal water along the shores of the Middle States and Southern New England laden with ripe ova, which they may deposit either on the sandy bottoms at a distance from land or in the entrance to the broad bays. With this new light I am prepared to believe that certain schools spawn in the rivers and sounds of the Southern States from Florida to North Carolina, as is confidently stated by several of our correspondents; indeed, I have had several strong testimonies from persons in Florida since writing paragraph 133. Although the facts are not sufficient to determine whether menhaden spawn on a falling temperature, like the herring, or on a rising temperature, like the shad, the latter view appears to be gaining in weight.

Capt. Robert H. Hurlbert, of Gloucester, a close observer, whose statements about the mackerel and cod I have often had occasion to test and never found inaccurate, assures me that in 1875, when with the mackerel fleet on the southern coast, he saw a number of menhaden, full of spawn, taken in the seine with a school of mackerel, twelve miles south of the Five-Fathom Bank light-ship, off Delaware Bay. This was late in April.

In late April, 1877, again, he seined ten barrels of fat, large fish off Chincoteague Shoals, on the eastern shore of Virginia. Their abdomens were much extended, and all which were examined proved to be full of spawn. Captain Hurlbert has caught them and examined numbers of them later in the season after fishing began in Block Island Sound, but has never seen spawn in them.

Capt. Henry E. Webb, of Milk Island, Rockport, Mass., states that twenty years ago he was in the habit of catching menhaden in the neighborhood of Cape Ann. He caught a few large ones every year before the great schools came in. These he cut up for bait, and occasionally found them full of spawn. He has never seen spawn in them after the middle of May. When a boy, as early as 1848, he lived at Riverhead, N. Y., near the eastern entrance of Long Island Sound. He says that he was accustomed to catch multitudes of young menhaden in a musquito-net seine toward the end of summer. These little fish

when they first came into the creeks were transparent and about half an inch long, but increased rapidly in size toward the end of the season, and in the fall measured four or five inches.

The parallelism between these facts and those connected with the spawning of the mackerel is very apparent. I regret that I must send this paper to press with the question of the spawning habits of the menhaden in such an unsatisfactory condition.

4. *Menhaden fishing on a Long Island steamer.*

[From advance sheets of an article entitled "Around the Peconics," by ERNEST INGERSOLL, in Harper's New Monthly Magazine for October 1, 1878, pp. 719-723.]

(Paragraph 174, p. 124.)

Loitering in comfortable indecision, I was fortunate enough to get an invitation from Captain "Jed" Hawkins to take a fishing cruise in his "bunker" steamer. The start was to be made at earliest dawn—an ungracious hour—and I was glad to leave the hotel in the evening, and avail myself of a sofa in the captain's snug state-room behind the pilot-house, so as to avoid the annoyance of getting up in the middle of the night. It was Sunday, and the little wharf was utterly deserted as I picked my way among the rubbish and piles of merchandise down to the steamer. Standing on the high deck, a picture of serene beauty spread before me. The air was perfectly still, the moon just fairly risen, and no sound was to be heard save the ticking of that mighty time-piece the tide, as its wavelets swung gently back and forth under the weedy piers or divided against the sharp prows of the smacks. It was light enough to show the spars and ropes of every craft, and all lay as motionless as though fixed in rock rather than floating in liquid, save the tremulous blue pennons on the topmasts. Then I turned in; and when I emerged, after an hour's pounding on my door (as it seemed) by the chuggety-chugging engines, we were far down Gardiner's Bay.

Last night the unruffled water was like bronze; now, under the soft silvery haze of the morning, the dancing surface became frosted silver, opaque and white save where the early sunbeams, striking through the mist, were reflected from the crests of the ripples in glancing ribbons of light. Shelter Island was an indistinguishable mass far astern; Long Beach light had ceased to twinkle; Orient Point was hidden in haze; Plumb Island, where eagles used to make their metropolis, and many fish-hawks now live, nesting on the ground with the gulls, was only a low bank of blue; Gull Islands could not be seen at all; and I only knew that Little Gull with its copper-bolted wall was there from the dot in the horizon made by its lonely light-house, and an occasional gleam imagined to be the surf breaking on the reefs at the Race. All this was northward. Southward the wooded bluffs of Gardiner's Island, with its natural breakwater and light-house, like a long arm reaching out between the outer and the inner waters, limiting the view. But this was soon left behind, and as the deep indentation of Napeague

came into view, the steamer's head was turned southeastward, toward Montauk, which, in the growing light, now stood out plain in every bleak feature of sandy dune and treeless moor. Now a very sharp lookout must be kept for fish, and after the substantial breakfast in the forecabin, I took my pipe and a place in the shrouds. Even then I could not look across Montauk, but could easily see two great ponds of fresh water, which nearly served to make an island of the Point. One of them, Fort Pond, was once a scene of sanguinary warfare between the Montauks and Narragansetts, the latter being beaten only by help from the Shelter Island Indians, who drove the invaders to their canoes.

Off Culloden Point the lookout excitedly announced, "Fish off the port bow!" The captain seized his glass, and scanned the water. So did I. "There's a big bunch," he shouts. "Watch 'em flirt their tails! Good color! See how red the water is!"

"O, yes; to be sure," I cry. "By Jove, that's a good color!"

My vacant face must have belied my words, but he didn't notice it. He was shouting, "Lower away the boats! Stand by to ship the nets!" furiously ringing signals to the engineer; giving hasty orders to the wheelsman; ensconcing himself in a pair of oil skin trousers, so capacious I half expected he would disappear altogether; and so, amid the roar of escaping steam, the creaking of davit tackle, the laughing excitement of the crews, and the rattle of rowlocks, I tumble head-foremost into a boat, and the steamer was left behind. Now the flirting of tiny tails was plainly visible, but I must confess that I did not learn to distinguish the reddish hue which indicates a school of these fish until much later in the day. The two large boats side by side were sculled rapidly toward the shore where the fish were seen, the forward part of each boat piled full of the brown seine, which extended in a great festoon from one to the other. There were four men in each boat, all standing up, and in our red shirts and shiny yellow oil-skin overalls we must have made a pretty picture on that sunny morning. Close by was a pound-net, where a porpoise was rolling gaily, notwithstanding his captivity; but by maneuvering we got the "bunch" turned away from it and well inshore, where the water was not too deep. At last we were close to them, and now came a scene of excitement.

"Heave it!" yelled the captain, and in each boat a sailor whose place it was, worked like a steam-engine throwing the net overboard, while the crews pulled with all their muscles in opposite directions around a circle perhaps a hundred yards in diameter, and defined by the line of cork buoys left behind, which should inclose the fish. In three minutes the boats were together again; the net was all paid out; an enormous weight of lead had been thrown overboard, drawing after it a line rove through the rings along the bottom of the seine. The effect, of course, was instantly to pucker the bottom of the net into a purse, and thus,

before the poor bunkers had fairly apprehended their danger, they were caught in a bag whose invisible folds held a cubic acre or two of water.

This was sport! I had not bargained for the hard work to come, to the unsportive character of which my blistered palms soon testified.

None of the fish were to be seen. Every fin of them had sunk to the bottom. Whether we had caught ten or ten thousand remained to be proved. Now, lifting the net is no easy job. The weight of nearly ten thousand square yards of seine is alone immense, but when it is wet with cold sea-water, and held back by the pushing of thousands of energetic little noses, to pull it into a rocking boat implies hard work. However, little by little it came over the gunwales, the first thing being to bring up the great sinker and ascertain that the closing of the purse at the bottom had been properly executed. Yard by yard the cork line was contracted, and one after another the frightened captives began to appear, some folded into a wrinkle or caught by the gills in a torn mesh (and such were thrown back), until at last the bag was reduced to only a few feet in diameter, and the menhaden were seen, a sheeny, gray, struggling mass, which bellied out the net under the cork lines and under the boats, in vain anxiety to pass the curious barrier which on every side hemmed them in, and in leaping efforts to escape the crowding of their thronging fellows. How they gleamed, like fish of jewels and gold! The sunshine, finding its way down through the clear green water, seemed not to reflect from their iridescent scales, but to penetrate them all, and illumine their bodies from within with a wonderful changing flame. Gleaming, shifting, lambent waves of color flashed and paled before my entranced eyes; gray as the fishes turned their backs, sweeping brightly back with a thousand brilliant tints as they showed their sides; soft, undefined, and mutable, down there under the green glass of the sea; while, to show them the better, myriads of minute medusæ hurried hither and thither, glittering like phosphorescent lanterns in gossamer frames and transparent globes.

All possible slack having now been taken in, the steamer approaches, and towing us away to deeper water, for we are drifting toward a lee shore, comes to a stand-still, and the work of loading begins. The cork line is lifted up and made fast to the steamer's bulwarks, to which the boats have already attached themselves at one end, holding together at the other. This crowds all the bunkers together in a mass between the two boats and the steamer's side, where the water boils with the churning of thousands of active fins. A twenty-foot oar is plunged into the mass, but will not suffice to sound its living depths. Then a great dipper of strong netting on an iron hoop is let down by tackle from the yard-arm, dipped into the mass under the guidance of a man on deck who holds the handle, the pony-engine puffs and shakes, and away aloft for an instant swings a mass of bunkers, only to be upset and fall like so much sparkling water into the resounding hold.

"How many does that dipper hold?"

"About a thousand."

"Very well, I will count how many times it goes after a load."

But I didn't. I forgot it in looking down the hatchway. The floor of the shallow hold was paved with animated silver, and every new addition falling in a lovely cataract from far overhead, seemed to shatter a million rainbows as it struck the yielding mass below, and slid away on every side to glitter in a new iridescence till another myriad of diamonds rained down. If you take it in your hand, the mossbunker is an ordinary-looking fish, like a small shad, and you do not admire it; but every gleaming fiery tint that ever burned in a sunset, or tinged a crystal, or painted the petals of a flower, was cast in lovely confusion into that rough hold. There lay the raw material of beauty, the gorgeous elements out of which dyes are resolved—abstract bits of lustrous azure and purple, crimson and gold, and those indefinable greenish and pearly tints that make the luminous background of all celestial sun-painting. As the steamer rolled on the billows, and the sun struck the wet and tremulous mass at this and that angle, or the whole was in the half-shadow of the deck, now a cerulean tint, now a hot brazen glow, would spread over all for an instant, until the wriggling mixture of olive backs and pearly bellies and nacreous sides, with scarlet blood-spots where the cruel twine had wounded, was buried beneath a new stratum.

"How many?" I asked when all were in.

"Hundred and ten thousand," replied Captain Hawkins. "Pretty fair, but I took three times as many at one haul last week."

"What are they worth?"

"Oh, something over a hundred dollars.—Hard a-starboard! go ahead slow."

And the labor of the engines drowned the spat, spat, spat of the myriads of restless little tails struggling to swim out of their strange prison, while I climbed to the mast-head to talk with the grizzly old lookout, who had been round Cape Horn thirteen times, yet did not think himself much of a traveler.

The cry of, "Color off the port bow!" brought us quickly down the ratlines and again into the boats.

That day we caught 250,000 fish, and made a round trip of a hundred miles, going away outside of Montauk Point, where it was frightfully rough after a two days' easterly gale. Great mountains of water, green as liquid malachite, rolled in hot haste to magnificent destruction on the beach, where the snowy clouds of spray were floating dense and high, and the roar of the surf came grandly to our ears wherever we went. Yet the difficulties were none too great for these hardy fishermen, who balanced themselves in their cockle-shells, and rose and sank with the huge billows, without losing their hold upon the seines or permitting a single wretched bunker to escape.

5. *The manufacture of sardines from menhaden.*

(Paragraph 189, p. 137.)

The New York Times, April 12, 1874, has the following account of the Port Monmouth factory :

"The scene at the fishing grounds off Sandy Hook at the height of the season is picturesque in the extreme. The day is usually a bright one, with just enough breeze to render the heat bearable and toss up the small white caps of the waves for the sunlight to sparkle on. The fishermen in their jaunty little ten-ton sloops have been lying off the 'grounds' since midnight. In the dim light of the early dawn the 'school' is descried approaching against the wind. The menhaden swims on the surface, and the serried ripples of myriads of fins cover the broad expanse for thousands of feet in every direction. The small boats are lowered, the long net, over 7,000 feet in length, and reaching 12 or 13 into the water, is carried out on both sides until the hapless fish are inclosed in a vast semicircle, through the meshy walls of which there is no escape, and from which they are ladled in thousands by the fishermen armed with small nets or 'scoops,' holding a peck apiece. The silly victims never think of escaping by swimming beneath the lower edge of the net, a few feet below the surface. The victims are then loaded on the sloops, which make sail as rapidly as possible for the factory dock at Port Monmouth. During rough or unusually breezy weather the general effect is greatly heightened. The flapping sails, careening boats, and spray-drenched fishermen, hauling on the seine with redoubled exertions in order to get in their catch before the wind freshens into a gale, forms a picture exhilarating even to old hands at the business. At the landing the fleet are greeted by the 180 employés in the factory, and the entire catch, often reaching a thousand bushels, is rapidly transferred to the shore. Then begins the more prosaic part of the process. The fish to be cured are selected from the catch, the medium-sized ones being preferred, their heads, tails, and entrails removed by a new machine, the exclusive property of the company, and their bodies transferred to the 'scalers.' Only from a half to a fifth of the original haul is used, two hundred bushels being the ordinary amount handled daily. These the 'scalers' seize and submit to the scraping-machine, a series of revolving curry-combs arranged on four lines of shafting 50 feet long, which frees each fish of its scales in the space of about a second and a half. As seventy or eighty men are at work, straining every nerve to get the 'catch' into the salt before the heat of the day, the rapidity with which the funny game are put through the various details is something startling. The 'cleaners' are long oval troughs of running water, over which revolves a series of brushes, something after the pattern of the 'scaler,' and which does all that its name implies in an almost equally short space of time. From this the fish go into the salting barrels, a stage of the work at which the men

take breath for the first time. In these the fish are allowed to remain for two or three hours, at the end of which they are thoroughly cured, and are transferred to the zinc-covered tables, 8 feet by 6, with raised edges. In this position water is poured on them, and afterwards drained off in tubes connecting with the corners. The cooking cans, tin boxes a little larger than the ordinary packing cans, next receive them, and are then placed in steam tanks, seven in number, of a capacity of a ton each. Here they are left for two hours, during which they are thoroughly cooked. After being taken out and packed in the regular market-cans, the fish are conveyed to other tables, on which the process of oiling is gone through. Olive-oil is poured on them until the cans can hold no more, and the latter then passed to the tanners, of whom the company employ thirty-five, to go through the process of soldering. From this department they are taken back into another set of steam-tanks to be heated for venting. When the tin is at a proper temperature the can is taken out and a small hole opened at one end, through which the hot air is suffered to escape, and the aperture is then hermetically sealed. In the room adjoining the cans are packed in wooden cases for shipping, two dozen to the case. The retail price per full-sized can, containing from seven to nine fish, is fifty cents; that of the same size of the French imported goods, \$1.10 in gold. The buildings of the company include a large factory, 360 feet long by 120 broad, and from four to five stories in height, and a boarding-house for their employes. The former contains the necessary rooms for the various departments of the work already described, together with the machinery and equipments, most of which are original with the present enterprise. The engine used is of fifty horse-power, amply sufficient for all ordinary purposes. The company board and lodge all their hands, make all the tin-work, cans, &c., and keep their own teams and carts for hauling their goods to the dock at Port Monmouth. The pay-roll of the establishment, excluding the board and lodging of all the workmen, is about \$3,000 a month, reaching during the busiest part of the season as high as \$1,000 per week. The boarding-house contains accommodations for 180 men, including dining rooms, sleeping rooms, &c. Everything is kept clean and in order, and the health and comfort of the inmates sedulously cared for. A long dock has been constructed near the entrance to the main building, in 15 feet of water, where the sloops and boats unload their cargoes. Several hundred thousand dollars have been invested in the business, the facilities of which are being enlarged annually. Besides the home business, done with every State in the Union, the company ship large consignments to foreign ports, including Liverpool, Hamburg, and other places. At the Vienna Exposition of last year their contributions attracted much attention, and were unanimously awarded the gold medal of honor and the grand diploma of merit. An agency was also established in that city for Austria and Russia, which has since acquired a fine business. At home they have received flattering indorsements and

congratulations from the first business houses of New York, Saint Louis, Cincinnati, and the other great cities, all speaking in high terms of the flavor and delicacy of the American sardine, and reporting large sales of the article. So great has been the demand that up to the time of the panic they were unable to fill the orders pouring in from various parts of this country and Europe. The fishing season this year commences late, having been materially delayed by the cold weather. The 'schools,' however, are expected in the vicinity of Sandy Hook by the 1st of May, after which the work will be prosecuted night and day to the close of the season."

6. *Small oil-trying works in Maine, 1860.*

(Paragraph 229, p. 165.)

The Gloucester Telegraph of February 22, 1860, states that the inhabitants of Brooklin, Me., manufacture annually from 500 to 1,000 barrels of pogy oil, worth from \$15 to \$20 a barrel.

7. *The use of fish for manure by the early colonists of Massachusetts.*

(Paragraph 268, p. 195.)

The following order from the records of the town of Ipswich, Mass., May 11, 1644, illustrates, in a comical way, the custom of using fish for manure in those early days:

"It is ordered that all doggs, for the space of three weeks after the publishing hereof, shall have one legg tyed up, and if such a dogg shall break loose and be found doing any harm, the owner of the dogg shall pay damage. If a man refuse to tie up his dogg's legg, and hee bee found scrapeing up fish in a cornefield, the owner thereof shall pay twelve pence damages beside whatever damage the dogg doth. But if any fish their house lotts and receive damage by doggs, the owners of those house lotts shall bear the damage themselves."*

8. *A fish-fertilizer company in Boston, 1860.*

(Paragraph 282, p. 210.)

"A company was established in Boston in 1860, prepared to grant licenses for treating fish under the patent of Messrs. De Molon and Thurneysen, dated March 6, 1855."†

* Coffin's History of Newbury, &c. Boston, 1845, p. 42.

† Cape Ann Advertiser, 1860.

EXPLANATION OF PLATES.

PLATE I.

Figure 1. *Brevoortia tyrannus* (p. 19), adult, 12 inches long, from Wood's Holl, Mass. Drawn by H. L. Todd.

PLATE II.

Figure 2. *Brevoortia tyrannus* (p. 19), young, 8 inches long, from Wood's Holl (No. 20,666 c). Drawn by H. L. Todd.

PLATE III.

Figure 3. *Brevoortia tyrannus*, subsp. *aurea* (p. 21). Drawn by H. L. Todd, from a specimen in the Museum of Comparative Zoology, Brazil.

PLATE IV.

Outlines showing the variations of *Brevoortia tyrannus* (p. 21):

Figure 4. *Brevoortia tyrannus*, subsp. *menhaden*, Wood's Holl.

Figure 5. *Brevoortia tyrannus*, subsp. *brevicaudata*, Noank, Conn.

Figure 6. *Brevoortia tyrannus*, subsp. *menhaden*, Saint John's River, Fla.

Figure 7. *Brevoortia tyrannus*, subsp. *aurea*, Brazil.

PLATE V.

Figure 8. *Brevoortia patronus* (p. 26), young? 8 inches long, from Brazos Santiago, Texas (892 a). Drawn by H. L. Todd.

PLATE VI.

Figure 9. *Brevoortia pectinata* (p. 30). Drawn by H. L. Todd, from a specimen in the Museum of Comparative Zoology, Rio Grande, Brazil.

PLATE VII.

Figure 10. *Brevoortia dorsalis* (p. 37), west coast of Africa. Outline from Bleeker's Plate.

PLATE VIII.

Figure 11. Fac-simile of plate accompanying Latrobe's description of *Clupea tyrannus* and *Oniscus prægustator*, (p. 15), from Transactions of the American Philosophical Society, Vol. V, 1802, Plate I.

PLATE IX.

Figure 12. Map showing geographical distribution of the North American menhaden, the annual movements of the schools, and the locations of the fishing-grounds and the oil-factories.

PLATE X.

Parasites of the menhaden. Drawn by J. H. Emerton:

Figure 13. Head of fish showing the position of the crustacean parasite (p. 102).

Figure 14. *Cymothoa prægustator* (p. 101).

Figure 15. *Laemonema radiata* (p. 104).

PLATE XI.

Figure 16. Map of the menhaden fishing-grounds of Maine (from Maddocks' Report).

PLATE XII.

Figure 17. Diagram of temperature strata in the Atlantic Ocean between New York and the Bermudas, April 24 to May 8, 1873 (p. 66). Copied from the "Reports of Capt. G. S. Nares, R. N. (H. M. S. Challenger), with abstract of soundings and diagrams of ocean temperatures in the North and South Atlantic Oceans, 1873."

PLATE XIII.

Figure 18. Diagram of temperature strata in the Atlantic Ocean between Halifax, Nova Scotia, and the Bermudas, (p. 66). From Captain Nares's Report.

PLATE XIV.

Diagrams illustrating the use of a purse-seine (p. 117):

- Figure 19. Section of seine showing cork-line and lead-line with bridle for pursing.
 Figure 20. Lower part of purse-seine showing the arrangement of the pursing weight.
 Figure 21. Diagram showing boat and method of pursing the seine.

PLATE XV.

Cape Ann seine-boat, with gear (p. 120). Drawn by J. H. Emerton:

- Figure 22. Seine-boat, 88 feet long, showing seine in position, ready to be set; pump, and other fittings.
 Figure 23. Section of stem of seine-boat, showing towing-links and gear.
 Figure 24. Pursing-blocks, showing method of attachment to thwart of seine-boat.
 Figure 25. Oar-rest and fastenings (new model).
 Figure 26. Oar-rest (old model).
 Figure 27. Purse-weight and pursing blocks.

PLATE XVI.

- Figure 28. Cape Ann dory, with details of construction (p. 123).
 Figure 29. Side of seining schooner, with seine-rollers.

PLATE XVII.

- Figure 30. A menhaden seining steamer (p. 123). (From Maddocks' "The Menhaden Fishery of Maine.")

PLATE XVIII.

- Figure 31. Diagram of the seining steamer "Leonard Brightman."

1. Pilot-house.
2. Gangway to forecastle.
3. Main hatch for stowage of fish.
4. Engine-house.
5. Towing-chocks.

PLATE XIX.

- Figure 32. Seining menhaden at Cape Ann (p. 125). (From a sketch by Mr. P. Center.)

PLATE XX.

- Figure 33. Seining menhaden in Peconic Bay (p. 124). From the "American Agriculturist."

PLATE XXI.

- Figure 34. Maine steamers seining menhaden (p. 126). From a sketch by Henry W. Elliott.

PLATE XXII.

The preparation of menhaden for bait (p. 147). Drawn by J. H. Emerton:

- Figure 35. Slivering menhaden.
 Figure 36. Bait-mill, perspective view.
 Figure 37. Bait-mill seen from above, showing knives.
 Figure 38. Roller of bait-mill.
 Figure 39. Bait or churn box, which, when in use, is fixed in the rigging, as shown in Plate XVI, Fig. 29.
 Figure 40. Bait-dipper.

PLATE XXIII.

- Figure 41. Knives for slivering menhaden (p. 147). Drawn by H. L. Todd.

1. Slivering knife, old style.
2. Slivering knife.
3. Slivering knife, modern style.
4. Slivering knife, old style.

PLATE XXIV.

- Figure 42. Factory of AMERICAN SARDINE COMPANY at Port Monmouth, N. J., (p. 137). Cut lent by Mr. F. F. Beals.

PLATE XXV.

- Figure 43. Factory of THE GEORGE W. MILES COMPANY on Charles Island, Milford, Conn., with floating factory "Alabama," (p. 171). Cut lent by Mr. Miles.

PLATE XXVI.

Figure 44. Factory at Napeague, N. Y. (p. 173). Cut lent by the "American Agriculturist."

PLATE XXVII.

Interior views of the factory at Napeague (p. 173): Cut lent by the "American Agriculturist."
Figure 45. Interior of the pot-works (old style).

Figure 46. Press-room (old style).

Cuts lent by the "American Agriculturist."

PLATE XXVIII.

Figure 47. Factory of Luther Maddocks at Booth Bay, Me. From "The Menhaden Fishery of Maine."

PLATE XXIX.

Figure 48. Factory of Joseph Church & Co. at Round Pond, Me. (p. 172). From "The Menhaden Fishery of Maine."

PLATE XXX.

Figure 49. The ship "Alabama" used by the George W. Miles Company for a floating factory (p. 171). From an India-ink drawing by H. L. Todd, copied by one of the photographic processes of Pennington & Co.

PLATE XXXI.

Figure 50. Factory of the Pacific Guano Company at Wood's Holl, Mass. Cut lent by the Company.

ALPHABETICAL INDEX.

A.		Page.			Page.
Abbe, W. A.	81		Atlantic Oil and Guano Company	80, 166, 185, 186, 187, 368, 369, 370, 371, 383, 384, 423	
Abbott, Dudley	96		Atwater, Prof. W. O.	4, 194, 237	
Abundance of menhaden, future	93		Atwood, Capt. Nathaniel E.	32, 97, 99, 142, 272, 277	
Abundance, past	78		Atwood, William	272, 404	
Abundance, present	79		Aumsuog	11	
Acidulated fish, manufacture of	226		Axillary appendages of menhaden	33	
Adams, Mr.	154		B.		
Adams & Co.	90, 169, 477, 478		Babson, Capt. F. J.	48, 75, 81, 98, 115, 124, 125, 136, 148, 180, 271, 273, 274, 395	
Adams, J. S.	452		Babson, Horatio	82, 277	
Adams, Capt. Nathaniel	118		Baird, Professor	1, 3, 41, 51, 62, 79, 100, 108, 109, 152, 160, 163, 172, 268, 274, 275, 277, 299, 290, 449	
Adamson's process	225		Bairdiella punctata	14	
Adulteration, menhaden oil used for	191		Bait, consumption of menhaden for	149	
Agassiz, Prof. L. J. R.	17, 33		Bait, annual sale of, by Maine manufac- turers	151	
Agriculture, loss to, from waste of fish	266		Bait, export of, to Dominion	156	
Agriculture, relation of fish products to	194		Bait fish, menhaden as a	141	
"Alabama," fishing steamer	171		Bait fishermen and others, conflicts be- tween	155	
Albula vulpes	14, 69		Bait-fishery, extent of, in New England	148	
Albuminoids	255		Bait-fishery in Merrimac River and Salem Harbor	148	
Alden, C. G.	211		Bait, menhaden for mackerel	142	
Alewife	7, 13, 14, 15, 70, 60, 90, 287		Bait, menhaden for cod	141	
Alien or outside fishes	68		Bait-mill	148	
Alimentary canal of menhaden	34		Bait, menhaden, in the coast fisheries	148	
Allen & Co.	80		Bait, value of menhaden for, affected by food	95	
Allen, G., & Co.	165		Balena mysticetus	105	
Allen, George R.	50, 106		Ball, H. O.	272, 425	
Allen, William S.	272, 413		Bankers	142	
Allison, W. O.	4, 192, 273		Barracuda	69, 88	
Allize	15		Barren Island Manufacturing Company	168, 175, 183, 189, 296	
Allyn, Gurdon S., & Co.	86, 120, 166, 175, 183, 188, 296, 293, 428, 432		Bartlett, Mr.	374, 403	
Almy, Otis H., & Co.	166, 296, 423		Bartlett, Mrs. John	162, 169	
Alosa pectinata	13		Bathylbus	94	
Alosa sapidissima	14, 69		Batuta, Ibu	258	
Ambrose, Rev. John	57, 53, 61, 64		Bay alewife	16	
American Agriculturist	173		Bayonet-fish	106	
American club fish	138		Beals, F. F.	137, 138, 273, 274	
Ammodytes lanceolatus	70		Bean, Dr. T. H.	4, 97	
Ammonia	234		Beebe, Captain	43, 76, 85, 116, 179, 182, 272, 432	
Ammoniated superphosphate, manufac- ture of	227		Beesley, Mr.	210	
Analyses of menhaden and whale	228		Bell, James H.	41, 90, 97, 107, 273, 454	
Anderton, J. L.	41, 90, 273, 460		Benson, J. B.	90, 273, 457	
Animals, menhaden as food for	140		Benzine process	178	
Animal nutrition, principles of	250		Bermuda Islands	14, 36	
Annual destruction of menhaden	109		Bessels, Dr. Emil	94	
Archosargus probatocephalus	70		Bigelow, James W.	278	
Argyrosomus clupeiiformis	14		Bingham & Co.	391	
Ashby, Benjamin	151, 159, 277				
Ashore, menhaden driven	107				
Associations of manufacturers	191				
Atherina	70				
Atkins, Charles G.	5, 49, 70, 72, 76, 96, 97, 99, 106, 127, 129, 170, 172, 199, 200, 205, 259, 271, 275, 276, 506				

	Page.		Page.
Birds attracted by the schools.....	71	Cape Cod Bay, movements of menhaden in.....	47
Bishop, J. H.....	167, 175, 183, 188, 296, 360	Cape Cod Oil Works.....	165, 296
Bisulphide of carbon process.....	178	Cape Cod region.....	113
Blackford, E. G.....	4, 155, 273	Cape Cod, movements of menhaden on south shore of.....	46
Bleaching-tanks.....	170	Cape Hatteras, movements of menhaden about.....	37, 91, 470
Block Island Sound.....	43	Capelin.....	70, 142
Blue-back herring.....	142	Capital employed by manufacturers of Maine Association.....	185
Bluefish.....	1, 12, 60, 70, 84, 91, 92, 106, 107, 109	Capture, apparatus of.....	117
Bluefish, Captain Spindel on the ravages of.....	108	Caranx trachurus.....	13
Bluefish, Professor Baird on the destructiveness of.....	108	Carbohydrates.....	255
Bluefish fishery, Statistics of.....	2	Carrigan, Christopher.....	144, 278
Boardman, G. A.....	36	Carrigan, Rufus.....	144, 278
Boardman, Samuel L.....	5, 49, 70, 76, 77, 96, 99, 106, 127, 160, 170, 172, 199, 200, 205, 259, 275, 276	Cartwright, B. C., & Co.....	167, 296, 444, 446, 448
Body, shape of, in menhaden.....	20	Casts of menhaden.....	290
Bonito.....	2, 51, 69, 106	Catalogue of specimens in the National Museum.....	289, 290
Bony fish.....	12, 79, 111	Catesby's Natural History.....	500
Booth Bay region.....	113	Cat-fishes.....	106
Bosc, M.....	286	Causes influencing arrival and departure.....	38
Bottom fishes.....	68	Centropistis atrarius.....	70
Bourne, Jonathan, jr.....	297	Ceroes.....	69
Bowen, Mr.....	451	Chadwick, Capt. Frank A.....	80
Bowing, John.....	178	Chænopsetta ocellaris.....	151
Boyd, Thomas.....	141	Chapman, R., & Co.....	167, 181, 428, 432
Bradford, Governor.....	195	Chase, Capt. Remark.....	83
Bradley, James.....	277	Chase, S. B.....	277
Brandt, Mr.....	289	Chatto, E. C., & Co.....	165
Brazil, menhaden of.....	17	Chebog.....	15
Bremen factory.....	379	Chemical methods of extracting oil.....	178
Brevoort, J. Carson.....	18, 95	Chemical terms in fertilizer analysis.....	234
Brevoortia dorsalis.....	37	Chesapeake Bay, factories on.....	168
Brevoortia menhaden.....	18	Chesapeake region.....	113
Brevoortia patronus.....	26	Chirostoma notatum.....	70
Brevoortia pectinata.....	30	Chogset.....	69
Brevoortia tyrannus.....	19, 70	Chum, menhaden.....	148
Brightman, Benjamin F.....	49, 75, 80, 114, 179, 128, 180, 271, 358, 360, 362, 364, 379, 402	Church, Rev. A. W.....	135
Brightman, L., & Sons.....	164, 165, 185, 186, 187, 369, 370, 371, 372, 379, 386, 423	Church, Daniel T.....	4, 40, 44, 75, 84, 88, 105, 107, 115, 124, 126, 165, 166, 174, 179, 181, 272, 273, 358, 360, 361, 362, 364, 365, 418
Brightman, William J., & Co.....	166, 175, 182, 188, 296, 297, 298, 360, 423	Church, Joseph, & Co.....	5, 88, 123, 164, 165, 169, 172, 174, 175, 181, 182, 185, 186, 187, 188, 296, 297, 368, 369, 370, 371, 372, 379, 386, 402, 477, 478
Bristol Oil Works.....	164, 165, 175, 185, 186, 187, 188, 296, 368, 369, 370, 371, 372, 379	Circular of inquiry.....	4, 268
Brown's Cove Works.....	164, 165, 175, 185, 186, 187, 296, 371, 372	Clark, G. H.....	168, 175, 183, 189, 296
Brown, Isaac.....	166, 175, 182, 188, 296, 360, 361, 365	Clark, Henry W.....	425
Bruce, Duncan.....	210	Clift, Rev. William.....	201, 203
Bug-fish.....	7, 103	Clubfish, American.....	138
Buggy-head.....	13	Clupanodon aureus.....	17, 21, 33, 34, 35
Bug-head.....	13	Clupea carolinensis.....	17, 287
Burnett, Nelson.....	168, 296	Clupea dura laevi mystax.....	17
Burning-oil, menhaden oil for.....	191	Clupea elongata.....	142
Burke, George W.....	272	Clupea harengus.....	70
		Clupea menada.....	17, 18
		Clupea menhaden.....	16, 18, 228
		Clupea neglecta.....	16
		Clupea sadina.....	17
		Clupea tyrannus.....	15, 18
		Coast or ranging fishes.....	68, 69
		Codfish.....	51, 61, 69, 92, 103
		Cod fishery.....	2
		Cod-oil.....	193
		Cole, Mr.....	204
		Colburn, F. E.....	360, 439

C.

	Page.
Collections of the National Museum.....	5
Collins, Mr.	205, 207
Colors of northern and southern fish	33
Comparative value of herring and menhaden for toll bait	143
Composting fish fertilizers	247
Compound-breathing fish.....	67
Conary & Co.	165
Condon, J. C. 49, 80, 165, 179, 180, 271, 274, 375, 376	
Conflicts between bait fishermen and others	155, 156
Conley, John.....	277
Connecticut, abundance of menhaden on coast of	85
Connecticut, claims of, to first manufacture of oil.....	162
Connecticut, factories in	166
Connecticut, fisheries of	116, 507
Connecticut method of icing bait	152
Connecticut smacks, consumption of bait by.....	151
Conner, Patrick	273, 478
Conover, Mr.	451
Cook, Charles & Co. 166, 175, 182, 183, 296, 297, 423	
Cook, Prof. George H. 79, 200, 205, 210, 228, 274	
Cook, John W.	83
Cooking-tanks.....	170, 171
Coombs, Captain	80
Correspondents, list of.....	271
Corwin, H., & Co.	167, 446
Cottle, Edmund	416
Cones, Dr. Elliott	20, 92
Crandell, Capt. Jared S. 43, 75, 85, 179, 272, 427	
Crane, L. G.	277
Critchett, George.....	143, 278
Crockett & Co.	163, 460
Crowell, Alexander.....	83
Crowell, Elisha.....	277
Crowell, A. F.	272, 488, 493
Crustacean, parasitic	101
Cumberland Bone Company	227, 491
Cybiium	69
Cyclopterus lumpus	69
Cymothoa pragustator	13, 102
Cynoscion carolinensis	70, 106
Cynoscion regalis	70, 106

D.

Dana, Richard H., jr	145, 161, 279
Dana, William D	259
Dankers and Sluyter	11, 12, 79
Darwin, Charles	18, 37
Darwin, Francis	264
Darwin's menhaden	18
Dates of appearance and disappearance of schools	53, 506
Davis, Marshall	114, 271
Davis, A. C	40, 91, 131, 183, 184, 273, 475
Davis, E. A	78
De Blois, E. T	81, 120, 272, 297, 360, 425
Decrease, the probability of future	93
Defriez, T. C	272
De Kay, Dr	3, 36, 79, 199, 274, 275, 286
De la Blanchero, M. H	57
Delaware, abundance	90

	Page.
Delaware Bay.....	41
De Molon process, the.....	208, 209, 212, 213, 514
Dell, George.....	81, 123, 297
D'Homergue, L. C.....	191, 192, 273, 276, 367
Dibble, David.....	198
Dill, Capt. Heman S.....	48, 82, 115, 179, 272, 405
Dinnel, Capt. Solomon.....	82
Diseases of menhaden.....	101
Dodd, A. W., & Co.....	398
Dodge, Joshua T.....	272
Dodge, Simeon.....	48, 75, 82, 85, 98, 115, 271, 399
Domestic animals, fish as food for.....	250, 264
Dominion, export of bait to.....	156
Dorosoma Cepedianum.....	14
Doubleday, E.....	289
Dougherty, Charles.....	36, 273
Doughty, Capt. C.....	168, 296
Drag-net.....	131
Dried fish, analysis of.....	238
Drying fish scrap.....	502
Dudley, H. L.....	4, 32, 42, 44, 72, 74, 75, 85, 86, 90, 105, 124, 168, 174, 175, 176, 187, 181, 183, 210, 272, 353, 360, 361, 362, 364, 365, 367, 493, 506
Dunoran, Thomas.....	423
Durfee, Thomas.....	423
Dwight, President.....	12, 198, 276

E.

Early writers, the testimony of.....	78, 507
Eaton, William	277
Eays, Winslow P	81
Edwards, Capt. J. B.....	45, 53, 272
Edwards, Vinal N.....	4, 45, 289, 290
Ell-whop	15
Ell-wife	15
Emerton, J. H	4
Enemies of the menhaden.....	104
England, Thomas	144, 278
English Government, claims of.....	157
Etymologies	10
Eucinostomus gula	14
Eucinostomus lefroyi.....	14
Europe, success of fish guano as a fertil- izer in	218
Excelsior Works	169, 477, 478
Exhaustion of soil by various crops	231
Exports of oil.....	503
Extracts from writings of ichthyologists relating to the menhaden.....	279

F.

Factories, advantages claimed for floating.	176
Factories in Connecticut	166
Factories in Maine	165
Factories in Maine, erection of	164
Factories in Massachusetts	165
Factories in New Jersey	168
Factories in New York	167
Factories in Rhode Island	166
Factories on Chesapeake Bay	168
Factories, description of	171-173
Factories on the southern coast	169
Factory model in the National Museum..	174
Fairchild, Mr.	358
Fanshawe, Vice-Admiral	147

	Page.		Page.
Farrington, Professor, experiments of, on fish-scrap vs. corn-meal as food for sheep.	260, 261	Friend, George, & Co.	278
	262, 267	Friend, Robert A.	49, 79, 80, 165, 175, 180, 183, 185, 186, 187, 188, 271, 274, 296, 369, 377, 378
Fatalities of menhaden.	270	Frye, Jed., & Co.	365
Fat-back.	7, 14	Future increase or decrease.	110
Feeding, what is essential to economy in.	255		
Fermentation of fish scrap.	247	G.	
Fertilizer, success of fish guano in Europe as a.	218	Gadus morrhua.	69
Fertilizers made from fish refuse.	219	Gage, George.	273, 479
Fertilizers, manufacture of fish, in the United States.	218	Galeocerdo tigrinus.	69
Fertilizers, menhaden and other fish in a fresh state used as.	195, 483	Gallup, B. F.	360, 361, 364, 365
Fertilizers, valuations of commercial.	235	Gallup & Holmes.	80, 81, 120, 164, 165, 175, 183, 185, 186, 187, 188, 296, 297, 368, 369, 370, 371, 372, 379, 382, 384, 403
Feuds of fishermen.	155	Gallup & Manchester.	80, 297, 379, 383
Field, David D.	199, 276	Gallup, Morgan & Co.	164, 165, 175, 183, 185, 186, 187, 188, 272, 296, 297, 368, 369, 370, 371, 372, 403, 417
Film over the eyes of fishes.	60	Gardiner Oil Works.	167, 428
Filter-press.	178	Gardiner's Bay, eleven factories in.	189
Fin-back whales.	105	Gar-fish.	106
Fins of menhaden.	20, 26	Generic relations of menhaden.	18
"Fish-driver."	126	Geographical range of menhaden.	35
Fish guano.	236	George's Banks fleet, consumption by.	150
Fish, Hon. Hamilton.	51, 62	George W. Miles Company, factory of.	171
Fish-house.	102	Georgia, movements of schools on coast of.	39
Fish-meal.	2	Georgiamen.	150
Fish refuse, fertilizers made from.	219	Gerring, Frederick.	278
Fisheries, alleged destruction of.	110	Gifford, Mr.	121
Fisheries, destructive influence of.	110	Gifford, Capt. John W.	83
Fisheries, menhaden.	113, 508	Gifford, Warren A.	83
Fisheries of great lakes, statistics.	2	Gill, Capt. Eldad.	83
Fishermen, estimates of number.	114	Gill, Herbert A.	4, 490
Fishes, coast or ranging.	69	Gill, Professor Theodore.	18, 20, 125
Fishes, local or bottom.	69	Gill-strainers.	34
Fishes, wandering or surface.	69	Gilles, E. P.	78
Fishing gangs, organization of.	176, 508	Gilpin, Dr. Bernard.	58, 59, 61
Fishing grounds, location of.	113	Gizzard-shad.	14
Fishing vessels.	114, 185, 297, 298	Glover, Joseph.	197
Fishing with shore seines.	134	Glover, W. H. H.	168, 296
Fithian, William Y., & Co.	87, 120, 167, 175, 183, 189, 296, 298, 448	Goessman, Prof. C. A.	4, 220, 237, 272, 485
Fitzgerald, Mr.	189	Goodale, Hon. S. L.	2, 4, 37, 96, 129, 139, 140, 177, 210, 213, 218, 220, 224, 253, 262, 271, 289, 361, 362, 364, 367
Flanders, Richard, & Co.	416	Goodale's "Extract of fish."	139
Flat-fishes.	69	Goodale's press process.	177, 224
Florida, abundance of menhaden.	92	Goode, Francis C.	103, 273
Florida, movements of schools on coast of.	39	Goodkind Brothers.	414
Flounders.	2, 51, 69, 151	Goose-fish.	69
Fly-tail seine.	131	Gorman, John E.	278
Foes, predaceous.	104	Grady, Thomas.	278
Food of the menhaden.	93	Graham, Capt. Hanson.	82
Food materials, composition and valuations of various.	256	Grand Banks fleet, consumption of bait by.	150
Food for animals, menhaden as.	140	Grant, John.	49, 80, 104, 271, 378
Food, preparations derived from menhaden.	137	"Grappling."	104
Ford, Avery & Co.	169, 296, 460	Gray, Albert, & Co.	164, 165, 175, 183, 185, 186, 187, 188, 296, 368, 369, 370, 371, 372
Fortin, Pierre L.	64	Gray, Benjamin H.	423
Foster, D. E.	42, 90, 273, 453	Gray, Thomas F.	166, 296
Foster, Hon. Dwight G.	146, 158	Green Brothers.	167, 296, 298
Fowler & Colburn.	167, 175, 183, 189	Green, H. P.	448
Fowler, Foote & Co.	164, 165, 175, 183, 185, 186, 187, 188, 296, 297, 370, 371, 372	Green, J., & Co.	423, 444, 446
Fowler, R. L.	208, 210, 439, 358, 360, 361, 363, 364, 365	Greentail.	7, 14
Foy, Capt. Svend.	216	Griffin & Vail.	168, 175, 183, 189, 296
Fresh fish, analysis of the.	228	Grow, Theodore.	276, 287, 289
Friend, F. W.	277	Ground-sharks.	69
		Grouven, Dr.	345

	Page.
Growth, rate of	31
Guano.....	191, 244
Guano, statistics of	187
Guano, Norwegian fish.....	214
Guano, table amount produced by manu- factures of Maine Association	185
Guano, statistics of manufacture	190
Gulf menhaden.....	17, 26, 36
Günther, Dr. C. A. G	17, 274, 276
Gurnards	69

H.

Habit, alleged changes of, in menhaden ..	74
Habits of herring	63
Haddock.....	69
Hakes.....	69
Halibut	51, 69
Halibut fishery statistics	2
Hall, James A.....	271
Hall, J. F	273, 481
Hall, William D.....	163, 164, 168, 169, 203, 218, 296, 492
Halliday, S. B	276
Ham, W. A	273
Hamilton, Ker. B	199
Hannan, Richard	143, 278
Hanson, Dr. K	215
Hard-head	7, 12
Hard-head shad.....	7, 135
Hardy, Henry	278
Hardy, Joseph	107
Hardy, 2d, Capt. Josiah	46, 82, 115, 272, 273, 410
Harker, F. J	169, 296
Harm, W. A	478
Harriman Point Company.....	377, 378
Hastings, John	185, 186, 187, 370
Hatch, Capt. Henry E.....	82
Hatch, W. F	169
Hathaway, A. J	83
Hatsell, W. F	183, 273, 477
Hatteras region	113
Havens, Mr	42, 75, 93, 116
Havens, J. S.....	168, 296
Havens, W. S	179, 182, 272, 273, 441
Hawkins Brothers	42, 76, 87, 116, 120, 167, 168, 182, 273, 274, 296, 297, 298, 443, 444, 446, 448
Heath, Harrison	96
Henneberg, Professor	254, 255
Hermit-crab	102
Herrick & Bayard	80
Herring	2, 7, 11, 14, 16, 70, 92, 138, 142, 157, 506
Herring family, conflict of names in	14
Herring, movements of, as influenced by weather	72
Hickory-shad	14
Hickson, James	278
Higgins & Gifford.....	5, 120, 122
Hinckley, jr., Capt. Thomas	45, 272
Hind, Prof. H. Y	36, 57, 58, 59, 60, 61, 63, 64, 97, 100, 112, 147, 275
Hinkley, Hon. J. T	205
Hippoglossoides dentatus	51
Hippoglossus vulgaris	69
Hogle drying machine.....	502
Holmes, William	361

	Page.
Homans, F. W.....	136
Hoope & Coit	138
Horse-mackerel	13, 84
Horton & Co	444, 446
Horton, E. A	278
Howland, W. H. H	166, 175, 182, 188, 296
Humprey, Mrs. B.....	80, 271, 387
Hurlbert, Capt. Robert H.....	103, 152, 271, 277, 507
Hyrtl, Prof. Joseph	34, 35

I.

Icing fish, methods of	152
Inaccuracies of observation and state- ment	6
Indians and early colonists, the use of fer- tilizers among	195
Information, sources of	3
Ingersoll, Ernest	508
Ingham, R. E	43, 76, 85, 116, 179, 182, 210, 272, 433
Inspection returns	136
Internal organs	34
Intestinal worms.....	104
Introduction of the use of menhaden bait.....	142
Irenæus Pattersonii	94
Irregularities of movements of menhaden.....	46
Isothermal lines.....	64

J.

Jackson, Prof. C. T	209
Jameson, William	4
Jelly-fishes.....	95
Jenkins, Dr. E. H.....	4, 273
Jennett, Wallace R	91, 107, 273, 474
Jenyns, Rev. Leonard	18, 30
Johnson, Edward	196
Johnson, H. W	64, 146, 279
Johnson, Prof. S. W	140, 155, 177, 212, 225, 229, 237, 256, 276, 362
Jones, J. Matthew	36, 271
Jones, Seaman & Co	168, 175, 183, 189, 273, 296, 298, 360, 444
Jordan, Alden H	271, 391
Josselyn, John.....	15

K.

Kane, Capt. D. P.....	37, 273, 482
Kane, P	377, 378
Kaiser & Martin	289
Kellner, Mr	249, 263, 264
Kelsey, E. R	167, 175, 189, 296
Kemps, Capt. David	39, 100, 108, 273, 481
Kennedy, Andrew	5
Kenniston, Cobb & Co	80, 164, 165, 172, 175, 185, 186, 187, 296, 368, 369, 370, 371, 372, 379, 382, 384
Kenniston, G. B	48, 75, 80, 97, 114, 179, 180, 183, 271, 274, 382, 384
Kenniston, William	206
Kenny, Capt. Reuben C.....	46, 82, 115, 179, 272, 414
Key West, no menhaden at.....	36
Knowles, Capt. Charles G. F	147, 273
Knowlton, H	278
Koch, Dr. Charles	273, 482
Koon, V., & Son	360, 361, 444

L.	Page.	M.	Page.
Lady-fish.....	69	Mackenzie, George.....	145, 278
Laidlaw, George.....	144, 278	Mackerel.....	70, 65, 64, 92
Lanman, Capt. Zephaniah P.....	82	Mackerel-bait, preparation of.....	147
Lathrop, A. F.....	46, 83, 115	Mackerel fishery.....	2
Latrobe, Benjamin H.....	15, 16, 17, 18, 19, 102, 274, 281	Mackerel, growth of.....	32
Launce.....	70	Mackerel, swimming habits of.....	71
Lawes, J. B.....	258	Mackerel, winter sojourn of.....	56
Lawler, Joseph.....	5	Maclea, James R.....	144
Lawson, Hance.....	41, 90, 93, 104, 117, 180, 273, 458	Maddocks, Luther.....	5, 50, 77, 112, 131, 132, 141, 156, 164, 165, 177, 178, 181, 183, 184, 185, 186, 187, 188, 223, 227, 271, 277, 296, 297, 358, 360, 361, 362, 365, 372, 379, 382, 384, 386, 396, 403
Laurie, Andrew.....	144, 278	Maguire, John.....	278
Leeches, parasitic.....	104	Maine, abundance of menhaden on the coast of.....	79
Legislation, protective.....	132	Maine Oil and Guano Association.....	165, 178
Legislative interference.....	112	Maine Association, men employed in fac- tories of.....	187
Leidy, Prof. Joseph.....	102	Maine Association, men employed in fish- eries of.....	187
Leighton, Andrew.....	278	Maine Association, capital employed by manufacturers in.....	185
Length of menhaden.....	31	Maine Association, average number of barrels of fish taken by fleet belonging to.....	186
Le Peley, M. Pleville.....	57	Maine Association, average number of gallons of oil produced by manufacturers of.....	186
Lepidosteus osseus.....	106	Maine Association, average number of steamers employed in fisheries of.....	186
Leslie, Charles C.....	40, 169	Maine Association, average number of tons of crude guano produced by manufact- urers of.....	185
Lesueur, M.....	286	Maine Association, average number of vessels employed in fisheries of.....	185
Levy, M.....	217	Maine, erection of factories in.....	164
Lewis, Mr.....	208, 218	Maine, experience in use of fertilizers.....	200
L'Hommedieu, Hon. Ezra.....	12, 78, 196, 197, 483	Maine farmers, success of, in feeding fish to sheep.....	259
Lighter boats.....	125	Maine, fisheries of.....	114
Lillingston, B.....	42, 75, 76, 107, 272, 437	Maine, Gulf of, menhaden.....	48, 50
Lillingston, F.....	87, 107, 116, 179, 272, 435	Maine, laws of.....	112, 132
Limits of geographical range of menhaden in 1877.....	35	Maine, manufacture of guano in.....	210, 223
Limits, maximum of temperature.....	55	Maine manufacturers, annual sale of bait by.....	151
Limits, minimum of temperature.....	53	Maine, menhaden fishing in.....	126, 507
Line-fisherman, consumption of bait by mackerel.....	150	Maine, conflict of fishermen in.....	156
Liparis.....	69	Maine, the claims of, to the discovery of menhaden oil.....	161
Literature, bibliography of, relating to menhaden.....	274	Mallotus villosus.....	70, 142
Local names and usages.....	6	Maltby, O. E.....	168
Local or bottom fishes.....	69	Man and fisheries.....	110
Locomotive powers of the young men- haden.....	98	Manchester, Antony.....	166, 296
Long Island, movement of schools on east- ern end of.....	42, 507	Manchester, Benjamin.....	166
Long Island Sound region.....	42, 113	Manchester, B. F.....	296
Look, John.....	416	Manchester, Isaac D.....	297
Lophius piscatorius.....	69	Manchester, James.....	166, 175, 182, 188, 296
Lord, James.....	36, 278	Manning, Charles G.....	90, 273, 465
Loring, David F.....	47, 82, 93, 107, 115, 148, 272, 407, 409	Manokin Oil Works.....	169, 296
Loring, Thomas.....	82, 115, 272, 403	Manufacture of fertilizers, early attempt at.....	208
Lothrop, Alonzo F.....	272, 412	Manufacture of fish manure.....	208
Loud's Island Oil Works.....	164, 165, 175, 183, 185, 186, 187, 296, 368, 369, 370, 371, 372, 379	Manufacture, processes employed in.....	170
Loveland, Mr.....	204		
Low, Maj. David W.....	150, 151, 277		
Lowrie, Charles.....	144, 278		
Lubricating, menhaden oil for.....	191		
Luce Brothers.....	43, 85, 86, 120, 167, 175, 183, 188, 272, 296, 297, 298, 418, 432, 433		
Luce, Edwin A.....	416		
Luce, Jason & Co.....	45, 83, 148, 179, 272, 416, 417		
Lugger-boats.....	275		
Lump-fish.....	69		
Lyman, Col. Theodore.....	68, 129, 276		
Lyon, Governor Caleb.....	200		

	Page.		Page.
Manufacture, statistics of	190	Mitchill, Prof. S. L.	3, 16, 17, 18, 63, 78, 101, 105, 274, 275, 286
Manufacturers, menhaden oil and guano ..	296, 297	Morgan, Elisha	162
Manure, fish as	200, 248, 265, 514	Morris, Albert	42, 90, 107, 116, 180, 182, 273, 451
Manure, manufacture of fish	208	Morris & Fifield	168, 175, 183, 189, 296
Marchant, Captain	45, 83, 105, 118	Morse-bonker	13
Marchant, C. B.	272, 416	Morton, Thomas	15, 195
Markets, reviews of the oil	193	Moss-banker	288
Marsbankers	11, 12, 13, 78	Moss-bonker, the	13, 284, 287
Marsh-banker	13	Moss-bunker	7, 9, 11, 12, 90, 111, 138, 163
Marsh-bunker	13	Mourt, George	196
Marshall, W. W.	81	Mouse-bunker	13
Martha's Vineyard Sound, menhaden in ..	45	Movements of menhaden	268
Martin, Chandler	271, 390	Movements of herring as influenced by weather	72
Maryland and Virginia, abundance of men- haden on coast of	90	Mud, bottom, Professor Verrill on	94
Massachusetts, abundance of menhaden on the coast of	81	Mud-minnow	67
Massachusetts, factories in	165	Mud-shad	14
Massachusetts fisheries	115	Mullet	60, 70
Massachusetts inspections of pickled fish ..	295	Munnawhatteaug	11
Massachusetts, laws of	133	Muscongus Oil Works	172, 402
Mattowacca	14, 70	Mustelus lævis	41
Maylert, Dr	367	Myrick, James H.	277
Mayo, J. C.	165, 376		
McDonald, Daniel	144, 278	N.	
McDonald, Sir John	158	Name preferable for adoption	10
McDonald, Lewis	80	Napeague, N. Y., factory at	173
McDonald, Roderick	144, 278	Naphtha process	178
McDonald, Samuel, esq	73	Narragansett Bay region	44, 113
McKay, James	146, 278	Narragansett Oil and Guano Company ..	166, 423
McKeen, James G.	143, 278	Nature, place of menhaden in	109
McKinnon, Dougald	278	Nelson, William H.	277
McLean, James R.	278	New England menhaden fishing	124
McLellan, John	278	New Hampshire, abundance	81
McNiell, William S.	278	New Jersey, abundance	90
Measurements, table of	22, 23, 24, 25, 28, 29, 30, 31	New Jersey, abundance	90
Mechanical methods of oil-extraction	178	New Jersey, factories	168
Megalops thrissoides	69, 106	New Jersey, movements of schools	42
Meinert, Dr. A.	215, 216, 217	New York, abundance	87
Melanogrammus æglefinus	69	New York, early oil works in	162
Men employed in fisheries	187	New York, factories in	167
Menhaden, origin of name	11	New York, fisheries of	116
Merchant, Horace M.	82	New York, halibut fleet	151
Merlucius bilinearis	106	Nickols, L., & Co	391
Merrimac River, laws for	133	Nichols, Thomas	297
Merrimac River and Salem Harbor, bait fishery in	148	Nichols, Capt. William	37
Merrimac River, mortality in	101	Nicholson, John	278
Methods of capture of menhaden	113	Nickerson, Caleb	277
Methods of handling the net	123	Nickerson, J. G.	185, 186, 187, 358, 402
Methods of oil and guano manufacture ..	220	Nickerson, J. G., & Co	370, 379, 384, 386
Micropterus nigricans	106	Nickerson, J. S.	297
Migrations	50, 62, 268	Nitrogen from Guano, comparison of yield of fish scrap	191
Migrations of menhaden, arguments against, extended	65	North American Oil Works	165, 296
Milbert, M. M.	286	North Carolina, abundance on the coast of	91
Miles Brothers	86	North Carolina, fat-back fishing in	131
Miles, George W.	32, 33, 43, 65, 86, 116, 168, 174, 179, 182, 272, 274, 437	North Carolina, movements of schools on coast of	40
Miles, George W., Company	4, 87, 88, 165, 167, 171, 175, 181, 182, 185, 186, 187, 188, 189, 296, 297, 370, 371, 372, 436, 439	Northern waters, a claim that menhaden may be acclimated in	100
Milner, Mr. James W.	97, 167, 290	Norton, C. B.	178
Mint Head Company	431, 432	Norton, Professor	208
Mississippi Sound	36	Norton, Thomas	416
		Norton, Z. D.	49
		Norwegian fish guano	214

	Page.		Page.
Norwood, George	82, 278	Phosphate of lime	191
Number of eggs in immature ovaries	96	Phycis chuss	69
O.			
Object of the memoir	1	Pierce, Albion K.	278
Ocean temperatures	52	Pierce, Erskine	166, 175, 181, 188, 296
Ocean trout	10, 138	Pierce, F. F.	296, 358
Oceanic sharks	69	Plant-food, essential ingredients of.	231
Oceanic sojourn	66	Plant nutrition, chemistry of	230
Oil, a comparison of the yield of, of the whale and other fisheries	190	Plumer, George W.	82, 278
Oil business in Maine, inception of.	164	Poggie	11
Oil, exports of	503	Pogy	7, 10, 37, 49, 159
Oil factories, locations of the	165	Poisson blanc	68
Oil factory, cost of an	174	Poisson de fond	68
Oil, grades of	192	Poisson de roche	68
Oil, the claims of Maine to discovery of menhaden	161	Poisson forain	68
Oil, menhaden, use of	191	Poisson nomade	68
Oil yield in different localities	183	Pollachius carbonarius	69, 106
Oil yield of northern fish	180	Pollock	69, 106
Oil yield of southern fish	183	Pomatomus saltatrix	1, 41, 70, 106
Oil manufacture, history of	161, 513	Pomolobus mediocris	70
Oil manufacture, methods of	169	Pomolobus pseudoharengus	13, 14, 70
Oil manufacture, principles involved in. .	169	Pompano	70
Oil manufacture, statistics of	190	Pond, J. G.	82
Oil, number of gallons produced in Maine	186	Pookagan	11
Old-wife	15	Popular names	7, 9
Olin, Washington	393	Porgy	11
Oliver, Washington	80, 271	Porgy chum	141
Olmstead, Frederick Law	140	Possibilities of future oil manufacture. .	226
Oniscus pręgnator	17, 103	Potter, Capt. William H.	76, 85, 116, 272, 428
Oreynus alliteratus	69	Pound-fishermen	110
Oreynus thynnus	69	Practical conclusions	249
Osler, Samuel	213	Prejudices and superstitions	6
Osmerus mordax	70	Preston, Jonathan, & Co	444, 448
Otis, James E.	163, 175, 183, 189, 296	Price, Capt. F. Frank.	167, 168, 297, 444, 446, 448
Ova of menhaden	97	Prices current of menhaden oil	193, 299, 300, 301, 302, 303
Owens, A. A.	273, 453	Prices of menhaden, different seasons ..	178
Oysters	2, 95	Prices proportionate to amount of oil con- tained in fish	180
P.			
Pacific coast, menhaden on	37	Proctor, Joseph O	150
Pacific Guano Company	166, 169, 227, 487	Pryer, Jasper. 165, 167, 168, 175, 187, 273, 296, 364, 503	
Page, Captain	18	Purse-boat	126
Pagel, Dr.	247	Purse-seine	117, 118, 124
Parasites of the menhaden	101	Q.	
Parnell, Mr.	289	Quinnipiac Fertilizer Company. .	166, 169, 175, 176, 183, 188, 227, 296, 297, 428, 432, 492
Parsons, Joseph D	87, 97, 116, 272, 296, 442	Quiabog Oil Company	167, 428, 432
Pauhagen	11	R.	
Payne, Benjamin, & Co.	167, 446	Race, Edward E.	81
Payne, G. H.	167, 296, 448	Radde, Mr.	217
Pelamys sarda	69, 106	Rafinesque, C. S.	276
Pemaquid Oil Works.	164, 165, 185, 186, 187, 188, 296, 297, 371, 372, 402	Range of menhaden, oceanic limits of. .	36
Perley, M. H.	64, 274	Range of allied species	37
Perrin, Edwin A	84	Range, preferred, of temperature	55
Pettingell, C. C.	277	Range, southern limits of	36
Pettingell, Capt. Charles C	82	Raynor, J. Norrison	168, 273, 296, 443
Pettingell, Capt. Moses	101, 136, 149	Raynor, W. C	168, 296
Pettit, M.	212, 213, 226	Rays	69
Pew, Charles H	278	Rease, Captain	83
Phillips, Barnet	4, 75, 135, 138, 273	Reed, H. W	273
Phillips, Eben B. .	104, 108, 115, 162, 165, 179, 181, 271, 273, 376, 387, 401	Refining, processes employed in	170
		Relation of the menhaden fishery to the fishermen and maritime villages.	131
		Relative values of different fertilizers. .	244

	Page.		Page.
Remoras	69	Seine-setter	126
Reports, menhaden oil	304	Seining, best time for	124
Reproduction of menhaden	269	Selden, G. Henry	273, 461
Revision of the American species	18	Seriola zonata	69
Rhode Island, abundance of menhaden in	84	Settling-tanks	170
Rhode Island, early manufacture in	209	Seymour, Horatio	110
Rhode Island, factories in	166	Shad	2, 14, 15, 16, 32, 69
Rice, John	61	Shadine	10, 138
Rich, M. N.	277	Sharks	84, 105
Richardson, Sir John	274	Shaw, John	58
Richardson, Henry	41, 90, 273, 464	Sheepshead	70
Rimbaud's classification criticised	68	Shepard, Joseph	39, 273, 479
Robbins, Isaac D.	107, 273, 460	Shiner	7
Roccus lineatus	70, 106	Shiverick, Mr	490
Robart, M.	217	Shrimp	94
Romer, William	378	Siluridae	106
Roosevelt, Robert B.	110	Simmons, Amassa	266, 296
Rose-fishes	69	Simpson, jr., A. W.	40, 41, 73, 76, 91, 94, 100, 106, 117, 131, 273, 465, 470, 471
Rosing, Anton	141	Sinclair, Peter	62
Round barrel	179	Sisson, Capt. B. H.	42, 75, 87, 105, 116, 162, 167, 174, 179, 182, 272, 273, 445
Round Pond Company:	164, 165, 175, 185, 186, 187, 188, 296, 368, 369, 370, 372, 379, 402	Slicks	95
Rudder fishes	69	Slivering menhaden	147
Ryan, Martin	144, 278	Slivers	142, 147, 148, 150
Ryan, Philip	144, 278	Sluyter, Dankers and	11, 12, 78
S.		Small, A. W.	277
Sailing-vessels	122, 298	Smalley, C. E.	277
Salem Harbor, bait fishery in	148	Smelt	70
Salmon	69	Smith, Mr	205, 207, 275
Salmon fishery of Columbia River	2	Smith, Cyrus	168, 176, 183, 189, 296
Salmonidae	138	Smith, Edward M.	110
Salmo salar	69	Smith, Green & Co.	168, 296
Salt Island Oil Company	167	Smith, J. V. C.	11
Salt mackerel replaced by menhaden	136	Smith, Capt. Nathanael	79
Salt, drawback on	136	Smith, Philip	272
Salts, potash	269	Smith, Prof. Sidney I.	3, 102, 103
Sanders, Capt. John D.	273, 451, 452	Smith, Sylvanus	143, 151, 277
Sandy Hook region	113	Smith, Thomas P.	279
Sardine, American	10, 148	Smith & Yarrington	168, 175, 183, 189, 296
Sardines, manufacture of	137	Soil, exhaustion of, by various crops	231
Sardines, qualities of American	138, 512	Soil, materials removed from, by various crops	232
Sargent, W. H. 50, 75, 79, 80, 114, 128, 179, 180, 271, 373		Solan goose	111
Sartell, Capt. W. S.	75, 76, 80, 271, 391	Somers Point Oil Works	452
Saunders, John E.	143, 278	Sources of error in investigation	5
Scad	13	South Bay Oil Company	168, 296
Scales of menhaden	20, 34	South, menhaden fisheries in	117
Scheibler, Dr.	215	South Saint George Oil Works	164, 165, 175, 185, 186, 187, 296, 372
Schmidt, Professor	214	Southern coast, factories on	169
Schooling menhaden, habits of	70	Southwick, J. M. K.	148, 200
Schools, arrival and departure of	38	Southworth, John	166, 296, 360
Schools, birds attracted by	71	Spanish mackerel	51
Schools, evolutions of	95	Spawning of menhaden	99, 507
Schools, movements of the	70	Spear-fish	69
Schubler, F. C.	215	Sphyræna borealis	69
Scomber scombrus	70	Spicer, Capt. William E.	37
Scott, Capt. P. A.	147	Spices, menhaden preserved in	138
Sculpins	51, 69	Spindel, Capt. Isaiah	45, 108
Scup	1, 2, 57, 70	Spix & Martin	17, 18, 21, 34, 276
Sea-bass	51, 67, 70	Sprague, William P.	80
Sea-herring	51	Squeteague	2, 70, 84
Seal-oil, annual production of	190	Stannard, George, & Co.	86
Sea-shad	14	Stapleton, Edward	277
Sea-trout	106	Steamers, menhaden	122, 186, 297, 508
Secretary of Treasury	3		
Seine-boats	120		

	Page.		Page.
Webb, Capt. Henry E	507	Wife	15
Weber, Mr.	262	Wilcox, Charles O.	423
Webster, Prof. H. E	290	Wilcox & Crittenden	5, 121
Weekes, Capt. Darius F.	83	Wilcox, Capt. Leander	76, 85, 272, 427, 428, 431
Weight of menhaden	31	Wilcox, Leander, & Co.	166, 176, 182, 188, 297
Weir fishing at Waquoit	123	Wilcox & Manchester	166, 296
Weir fishing for menhaden	129	Wilder, Moses L.	78, 260, 264
Weiske, Mr.	263	Wildt, Mr.	249, 263
Welch's Point Oil Company	167, 439	Wilkinson, S. H.	36, 273
Wells & Co.	164, 165, 175, 185, 186, 187, 188, 296, 402	Willard, Enoch G.	277
Wells, Daniel D.	162, 163, 164, 442, 448	Willard, H. E.	277
Wells, Deblois & Brown	379	Williams, Rogers	11
Wells, D., & Sons.	167, 444, 446, 448	Wilson, Job T.	297, 361, 370, 423
Wells, Henry E.	163, 167, 297	Wilson, Job T., & Co.	166, 175, 182, 185, 186, 187, 188, 377, 378
Wells, Walter.	97	Wind and weather, influence of	72
Wells, W. A., & Co.	368, 369, 370, 371, 372	Winter sojourns of fishes	56
Westbrook Oil Company	176, 189, 297	Winslow, Capt. S. H.	82
Whale, analysis of flesh and bones of	228	Wolf, A. G.	42, 90, 103, 116, 180, 182, 273, 450
Whale fisheries, statistics of	2	Wolff, Dr. Emil	256, 263
Whale, flesh of the	229	Wonson, Frederic G.	126, 278
Whale-lice	103	Wonson, W. C.	278
Whale-oil	192	Wrayton, Michael	278
Whale, steamed bones of the	229	Wurdemann, G. B.	36, 289
Whalcs	104		
Whaley, Joseph.	44, 76, 272, 449	X.	
Whelen, Mauris	278	Xiphias gladius	69, 106
Whitcher, W. F.	63, 64		
White, Prof. Charles A.	141	Y.	
Whitefish	7, 12, 60, 68, 84, 164	Yarrell, William	64
White, Gilbert	57	Yarrow, Dr. H. C.	20, 92, 273, 275, 290
White, Isaac	296	Yellow-tail	7, 33
White, Isaac, & Co.	166, 176, 182, 188	Yellow-tailed shad	14
White, J. G.	365	Yield, possible, of extract of fish	140
White-shad	14		
White Wine Brook Company	164, 165, 384	Z.	
Whiteaves, J. F.	36, 100, 274, 275	Zoological names of menhaden	15
Whiting or silver hake	106	Zostera marina	93
Whitten, O. B.	277		

Fig. 1.

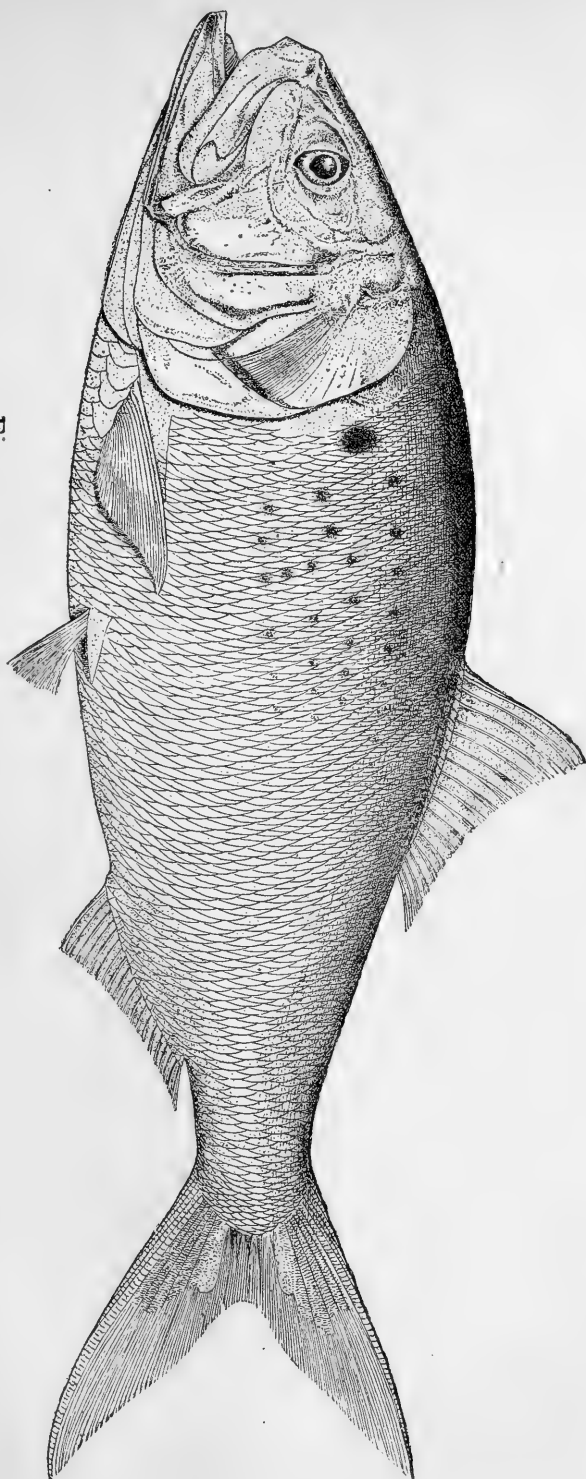




Fig. 2.

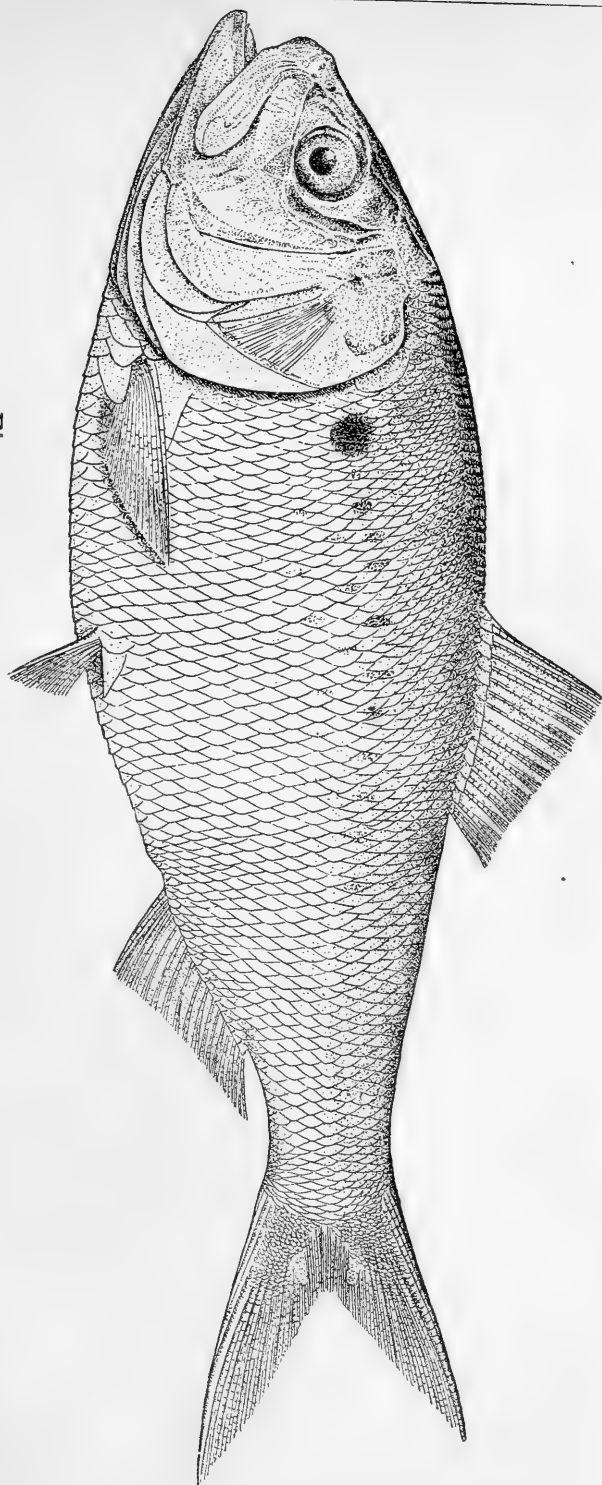
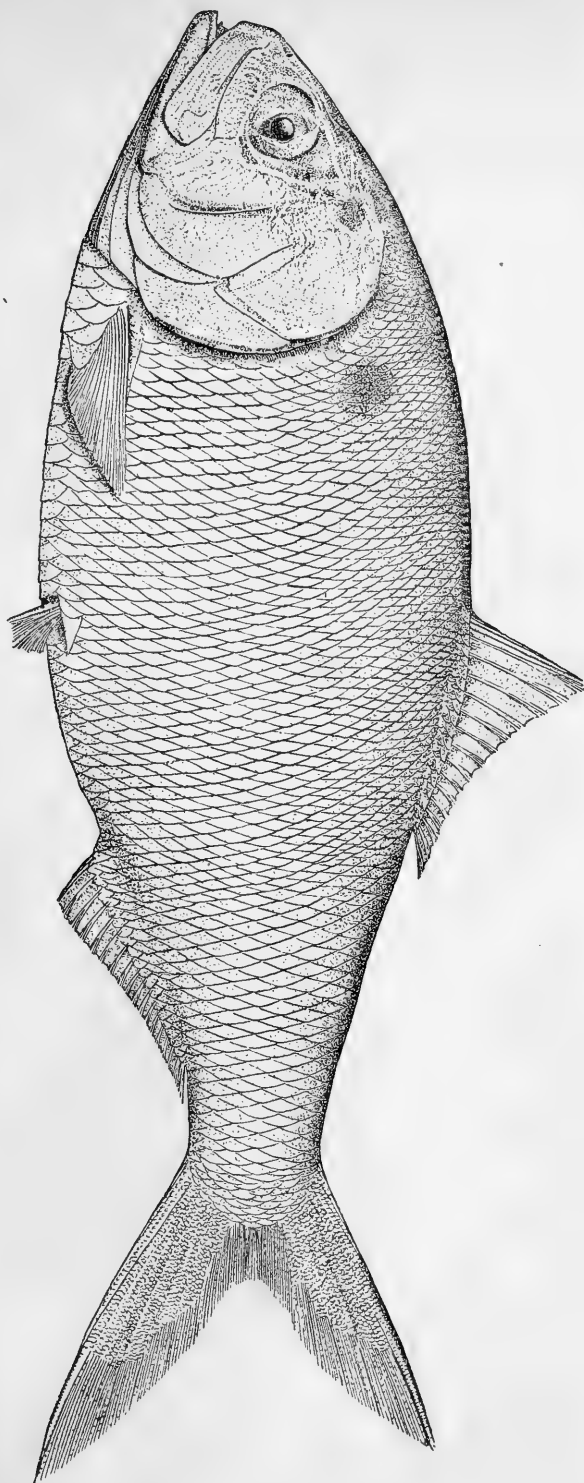


Fig. 3.



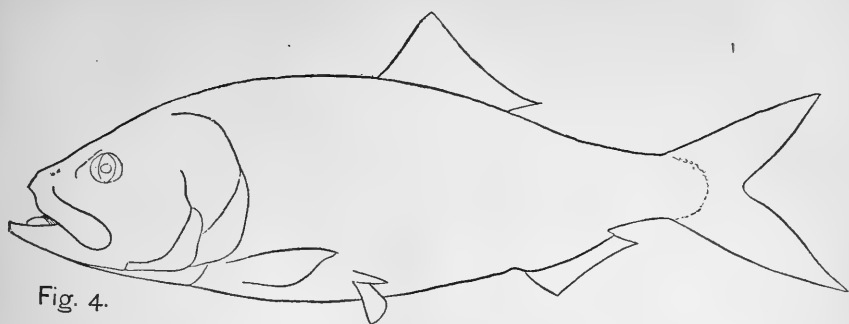


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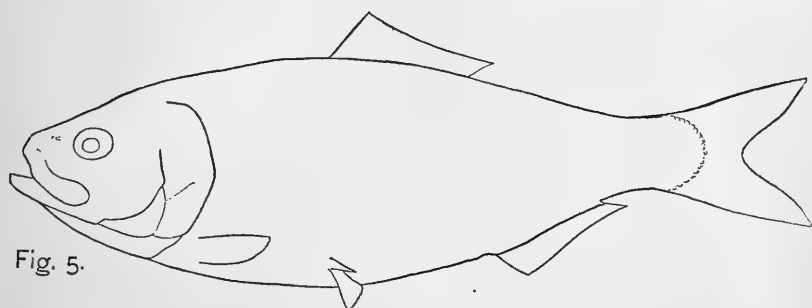


Fig. 5.



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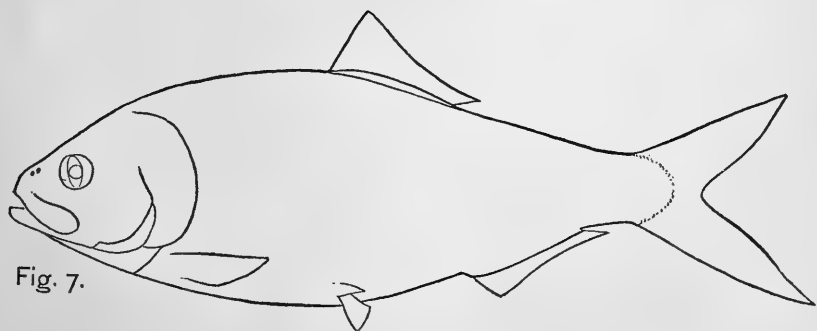


Fig. 7.

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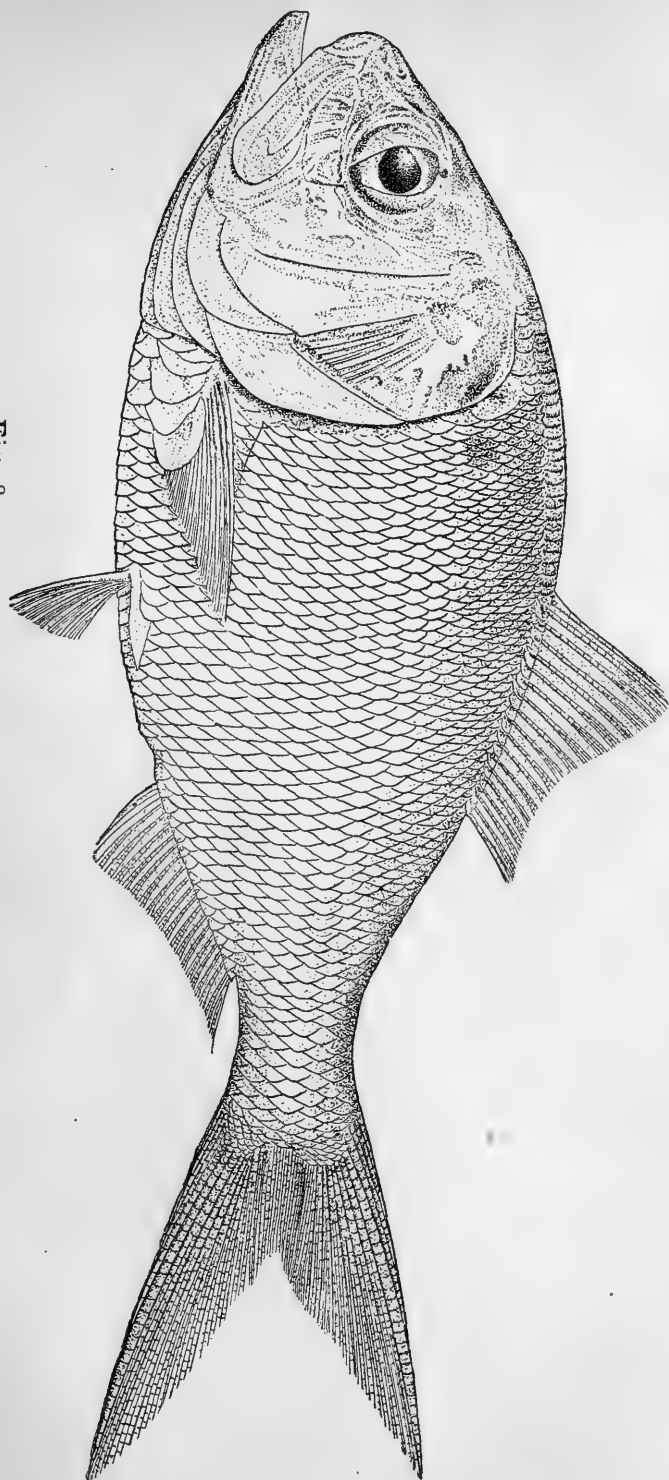




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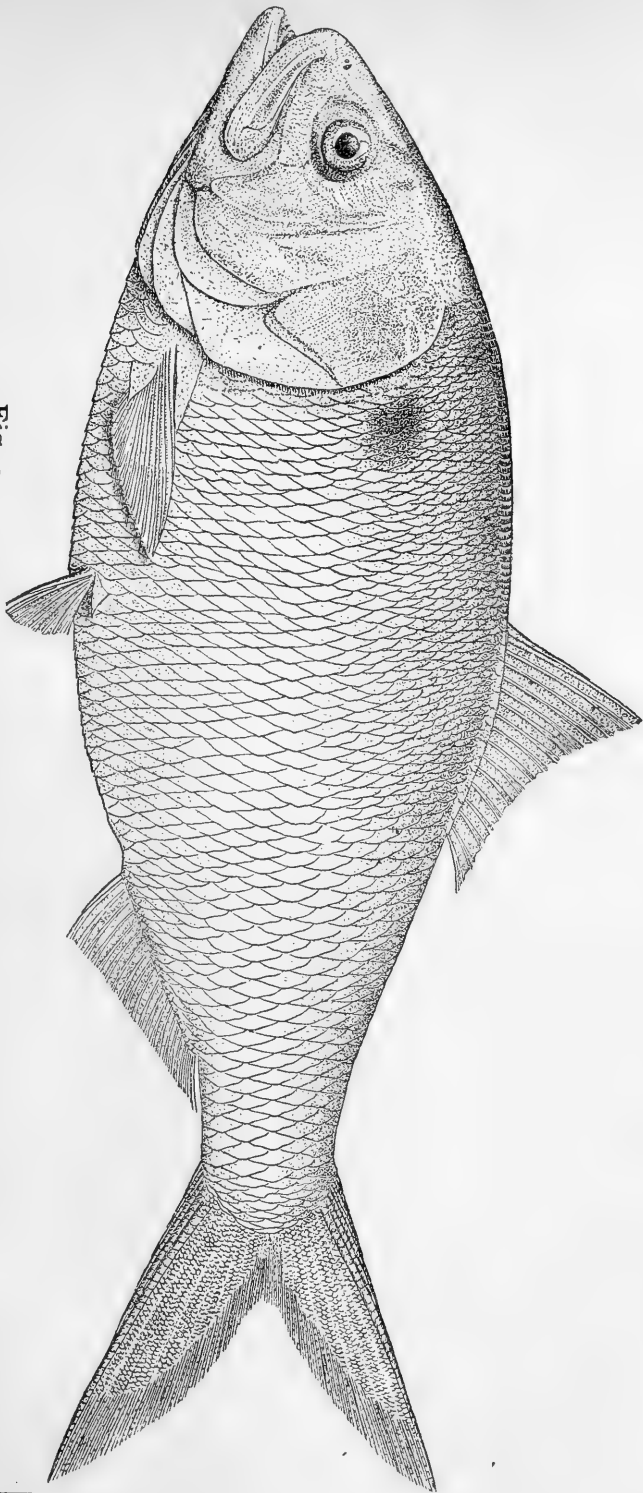
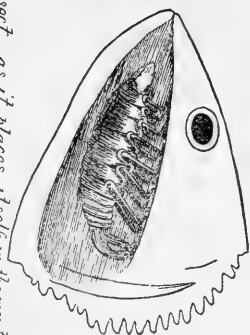
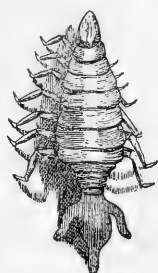


Fig. 10.





The Oniscus praegustator, drawn to its natural size, by measurement.



The Insect, as it places itself in the mouth of the Clupea tyrannus.

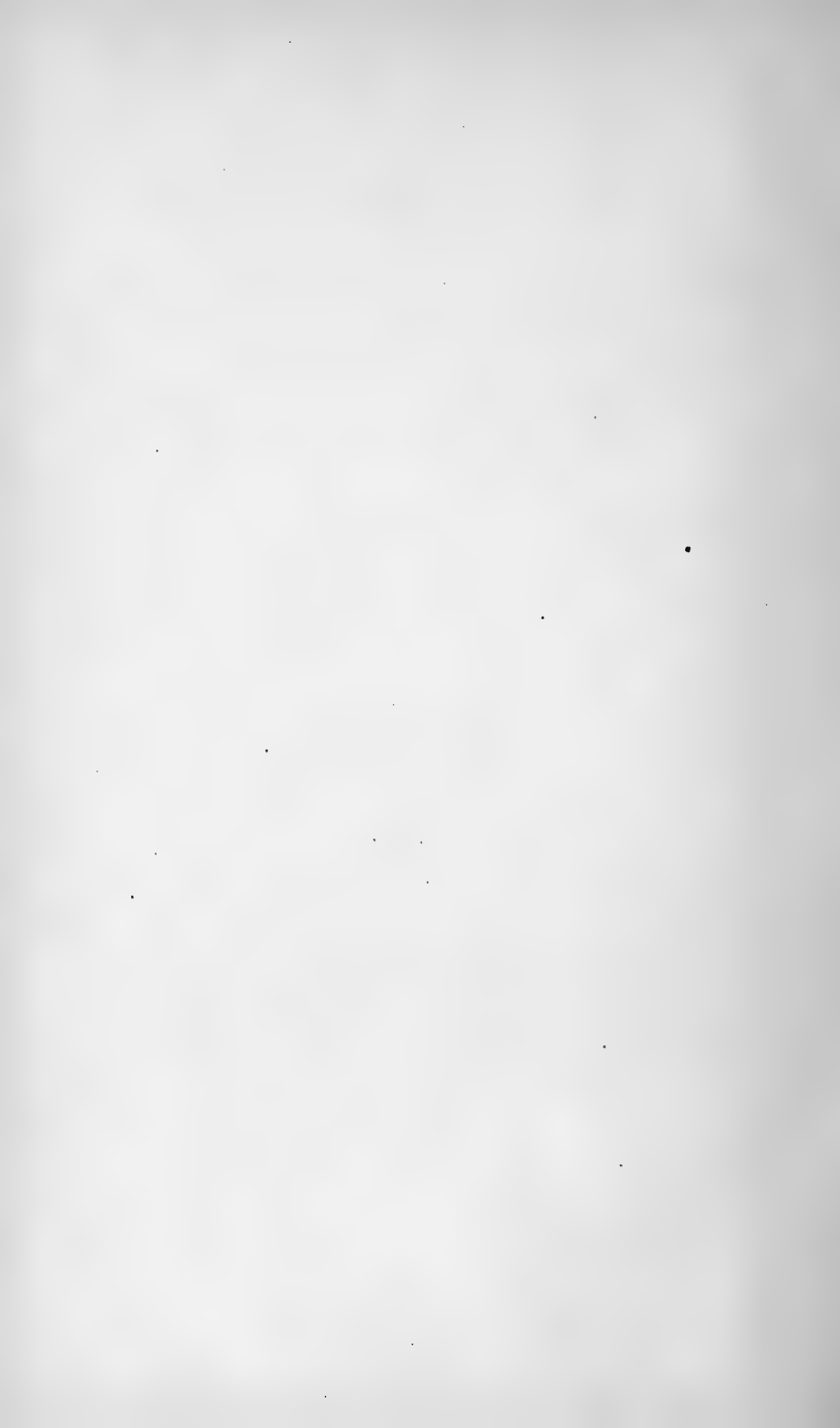


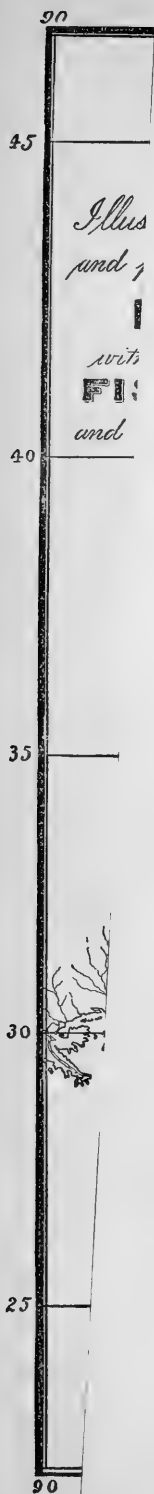
Leeches found upon the Insect

Outline of the Clupea tyrannus correctly drawn to its natural size.



Facsimile of plate accompanying Latrobe's description of Clupea tyrannus and Oniscus praegustator.

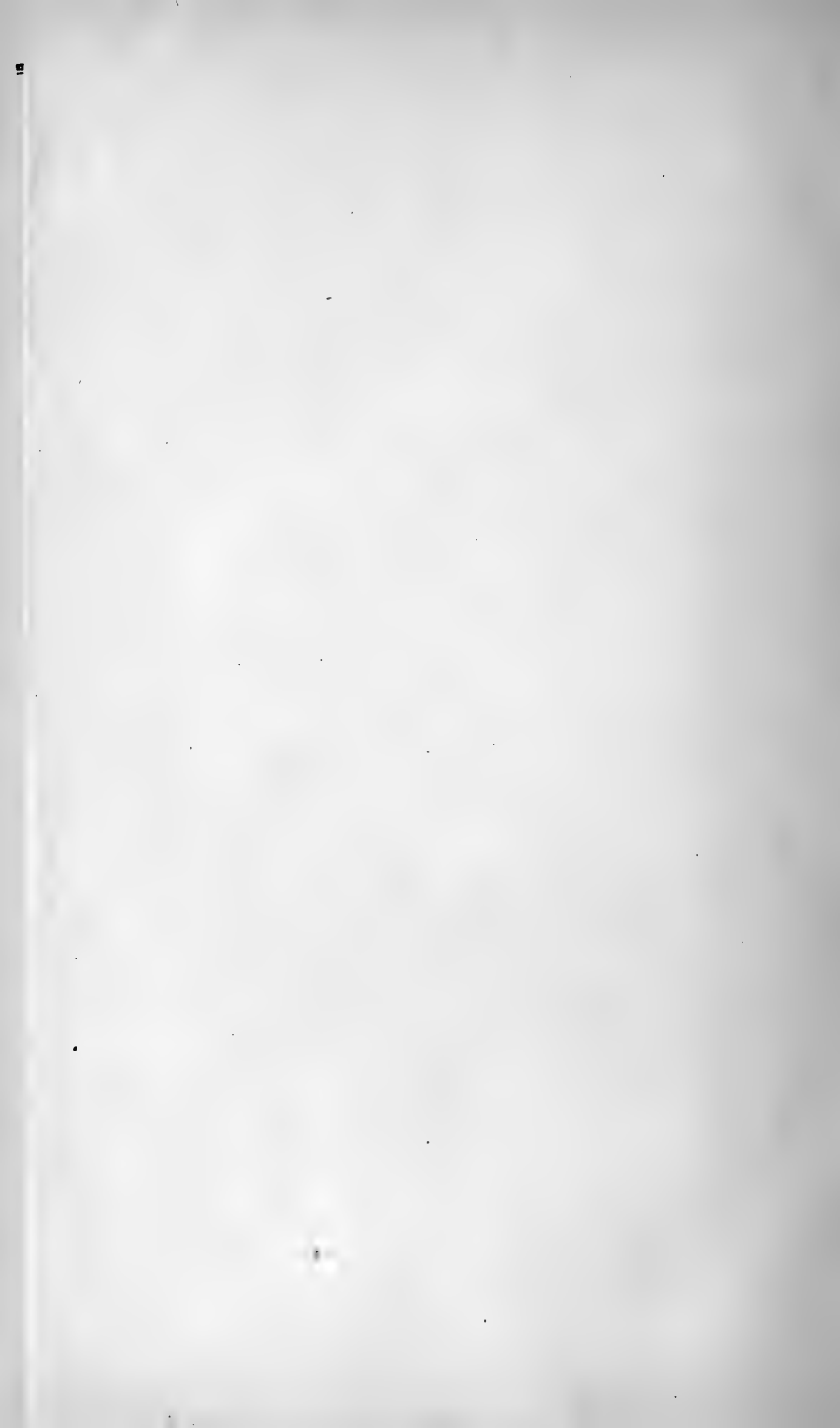




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with locations of the
FISHING GROUNDS
and Oil and Guano Factories.





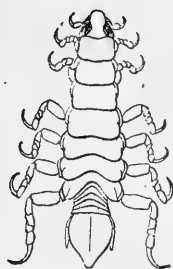


Fig. 14.



Fig. 15.

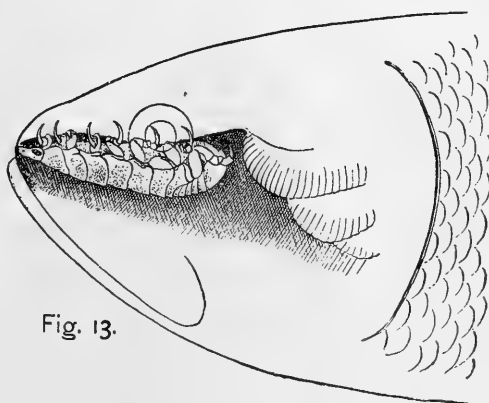


Fig. 13.

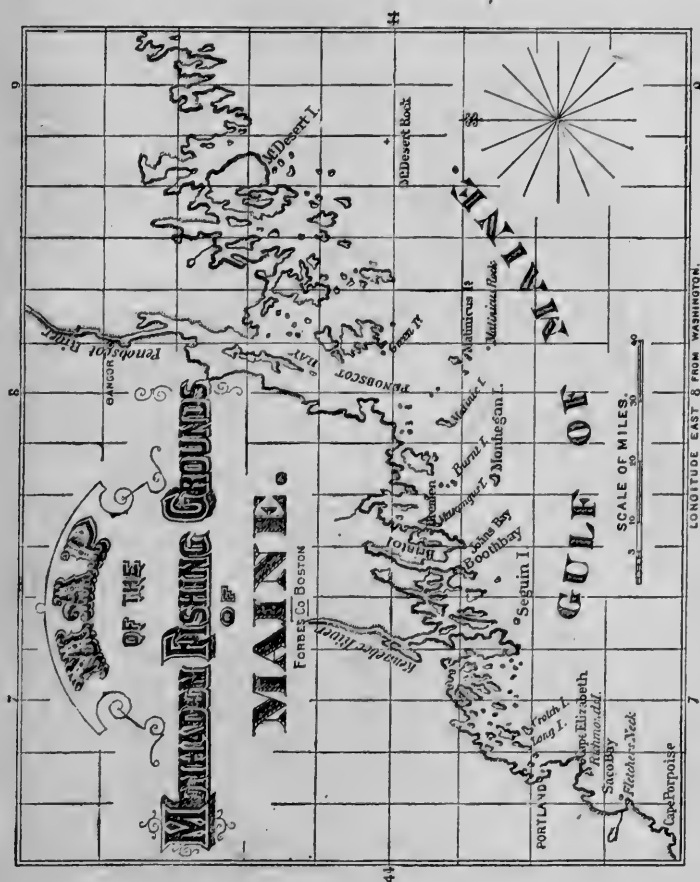
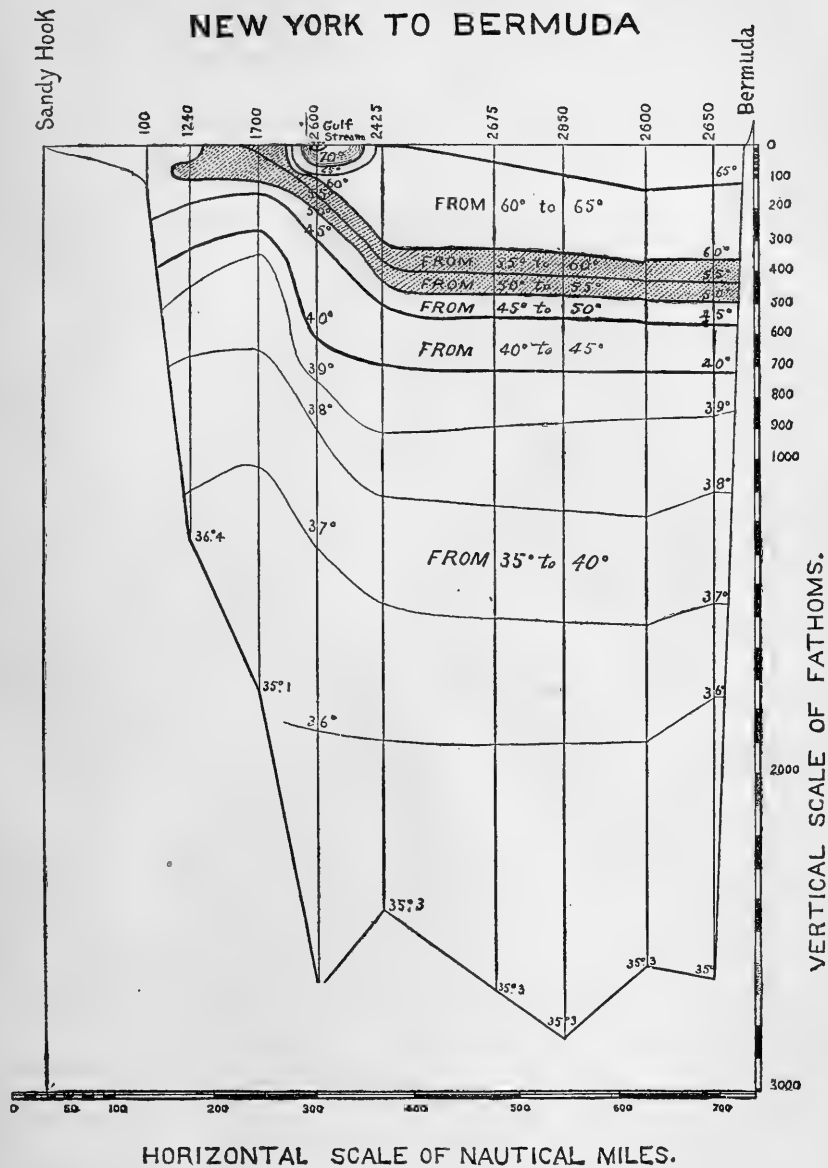
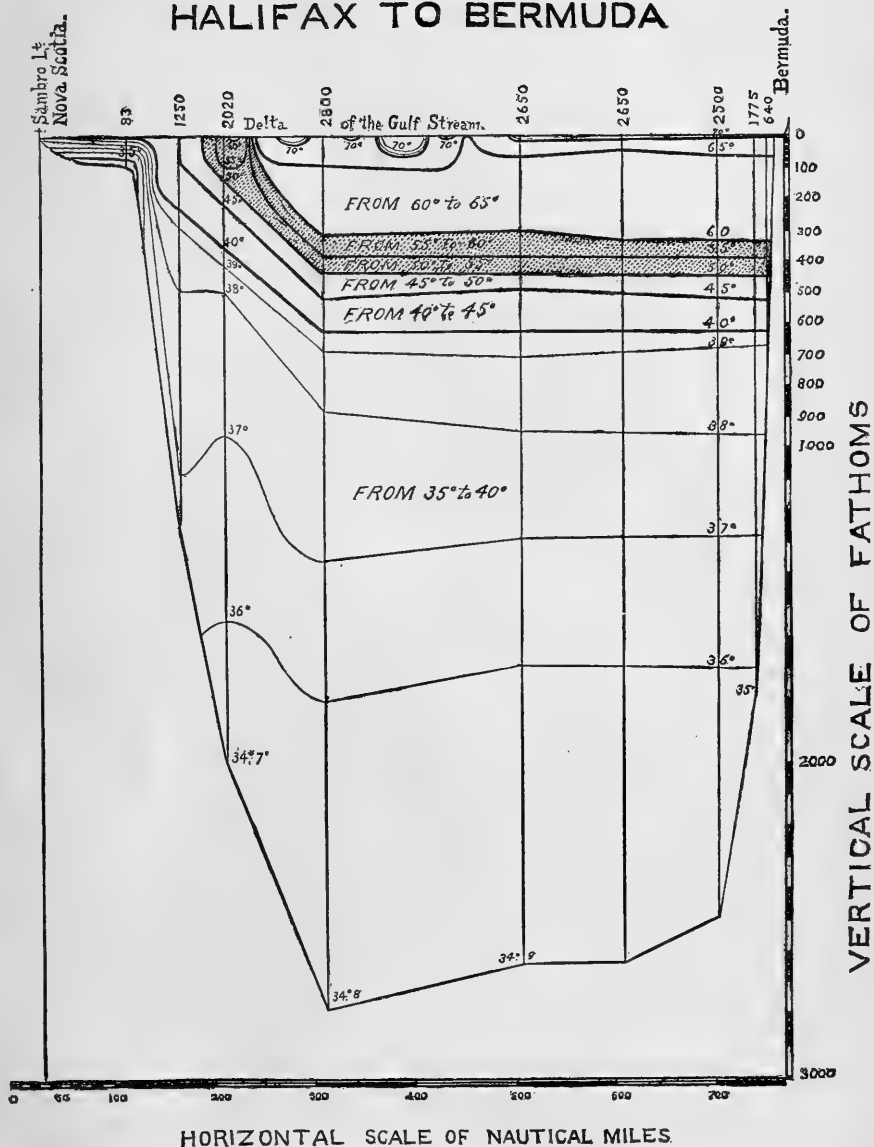


Fig. 16.

NEW YORK TO BERMUDA



HALIFAX TO BERMUDA



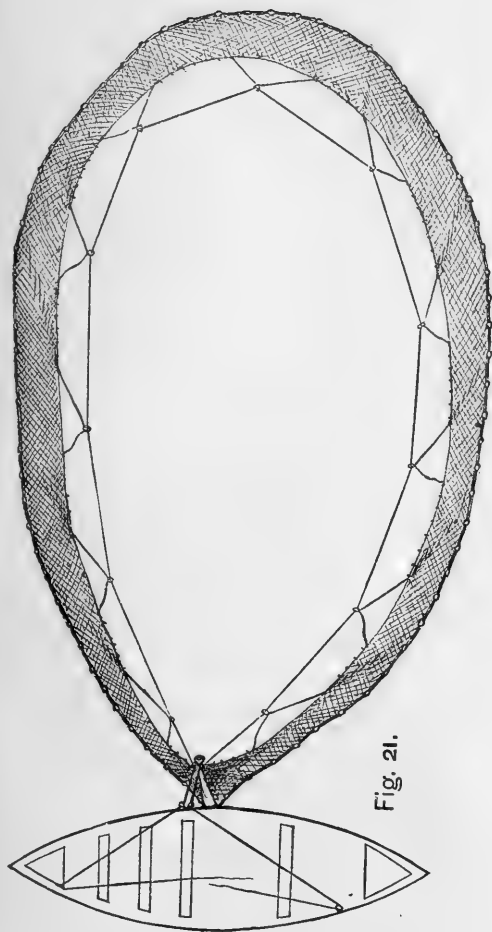


Fig. 21.



Fig. 20.

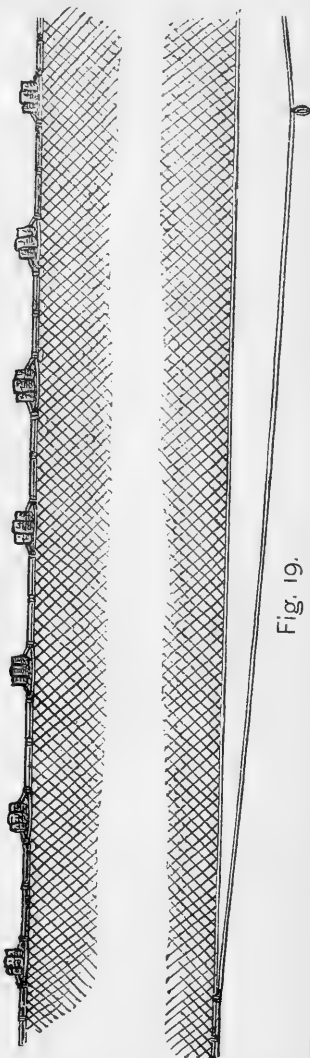


Fig. 19.

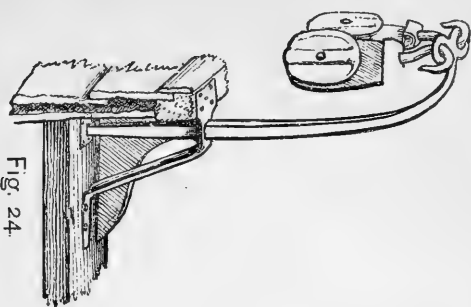


Fig. 24.

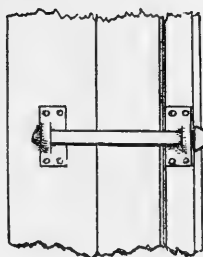


Fig. 25.

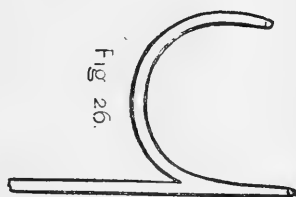


Fig. 26.

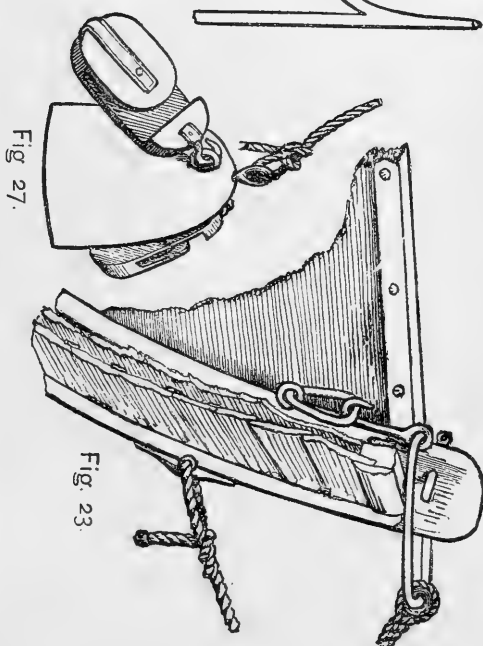


Fig. 27.

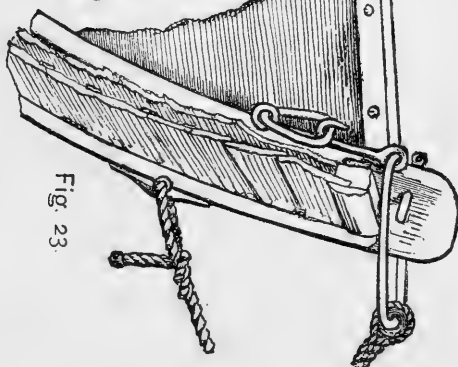


Fig. 23.

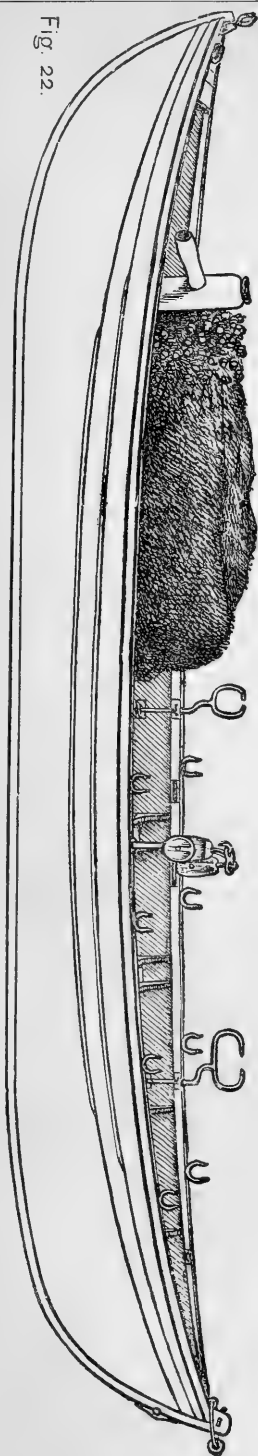


Fig. 22.



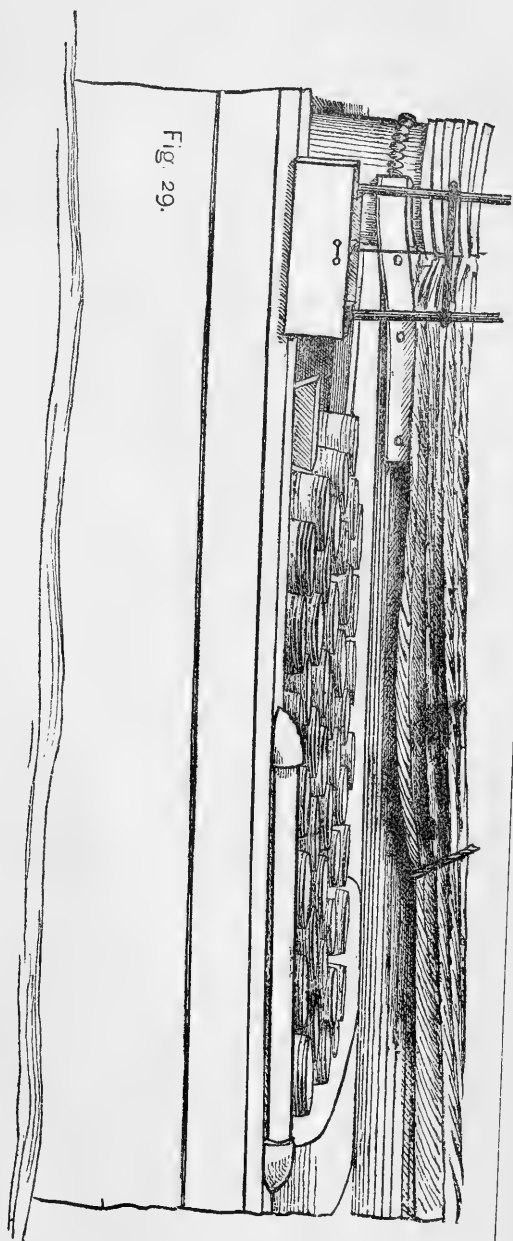


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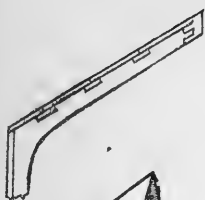
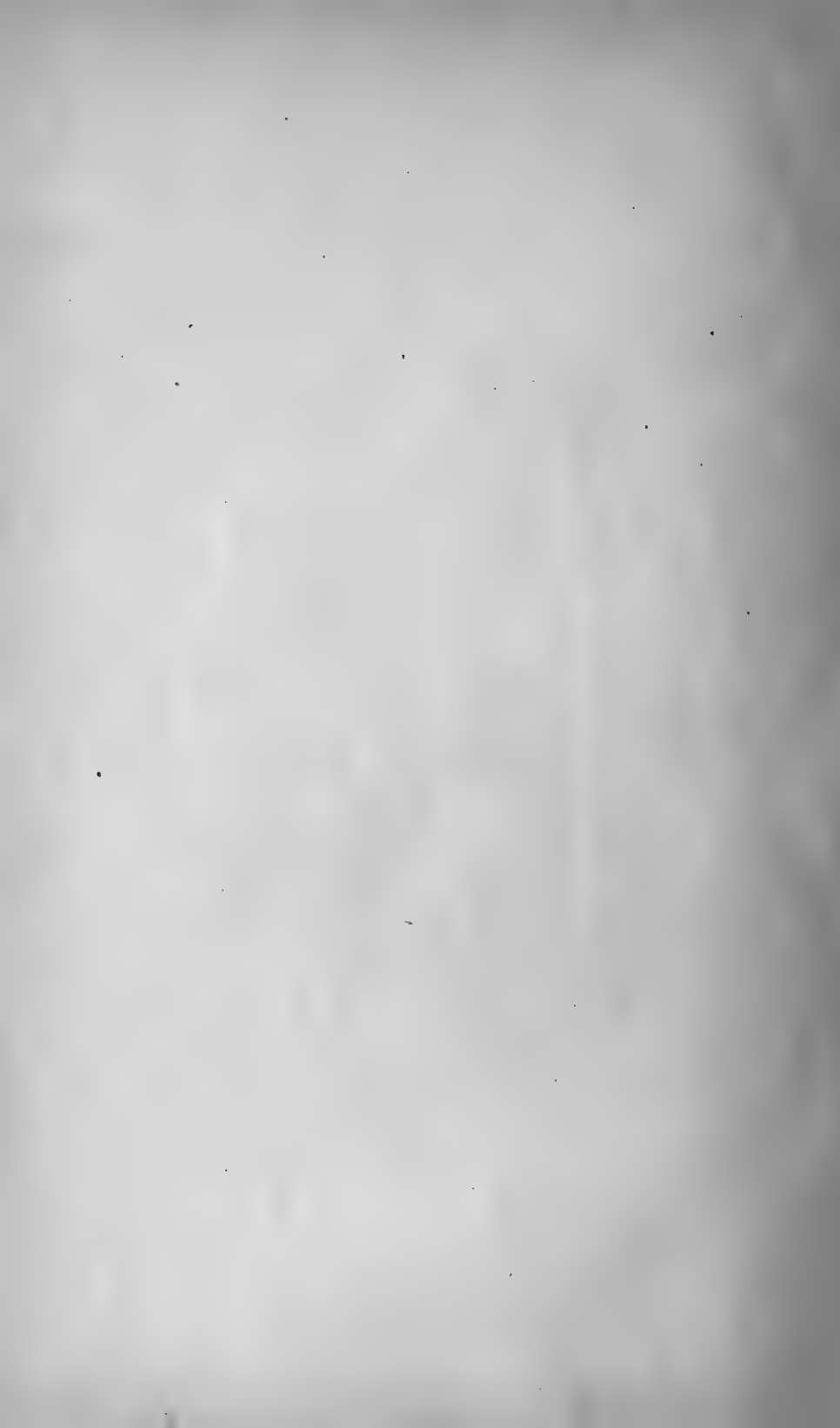


Fig. 28.



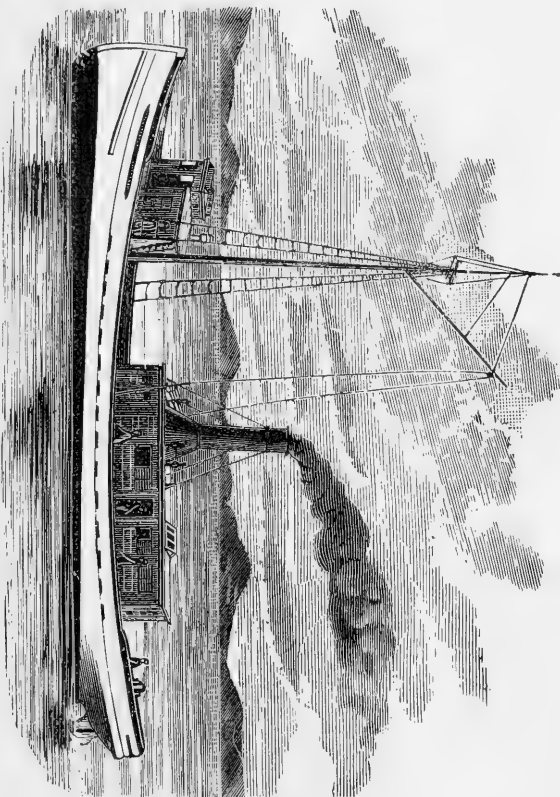
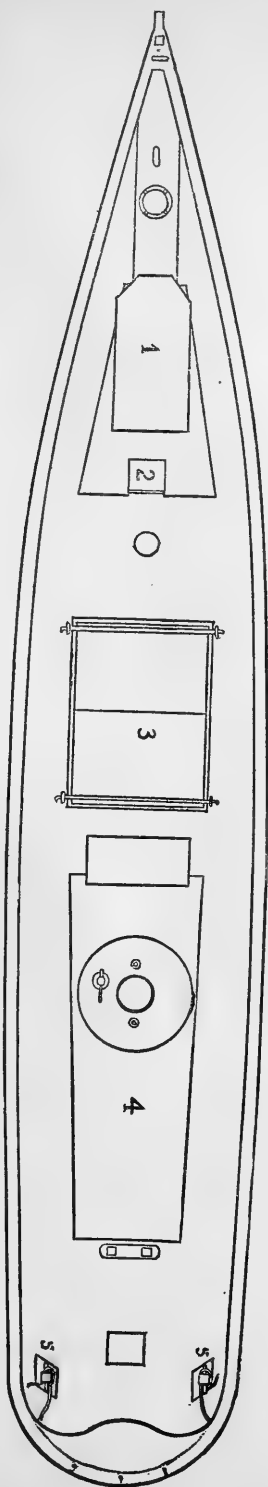


Fig. 30.

A MENHADEN FISHING STEAMER.

1. Pilot House
2. Gangway
- 3 Main Hatch for stowage of fish
4. Engine House
5. Towing Chocks.

Fig. 31.





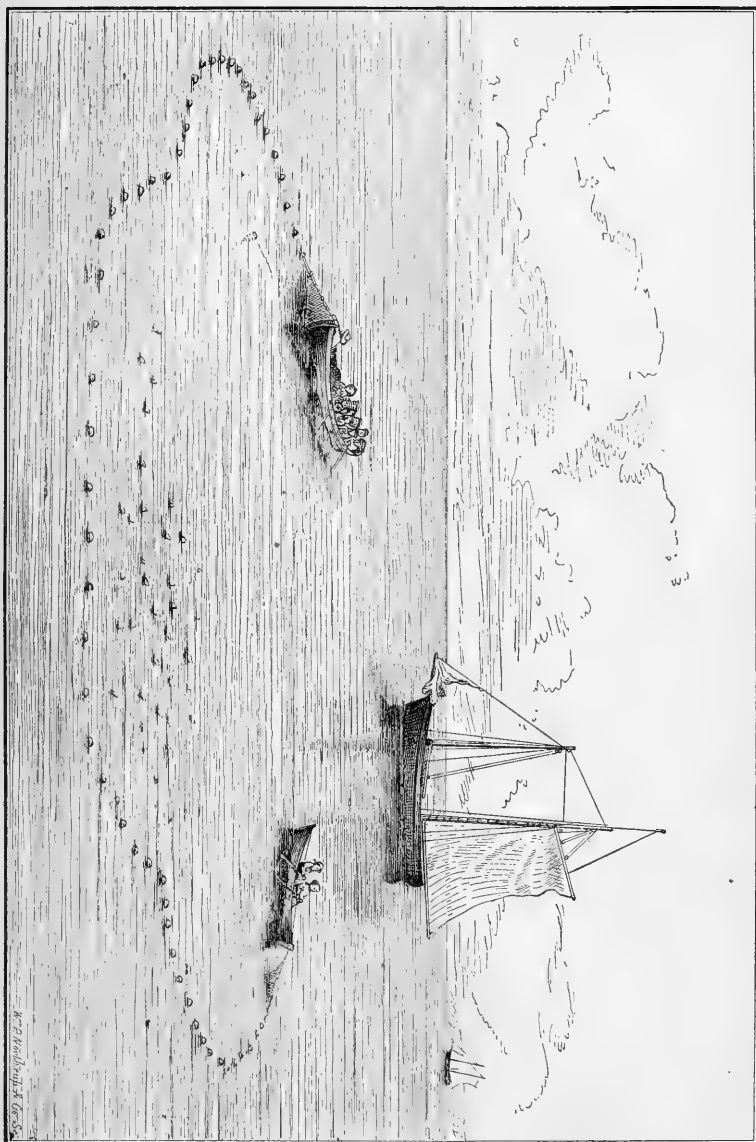
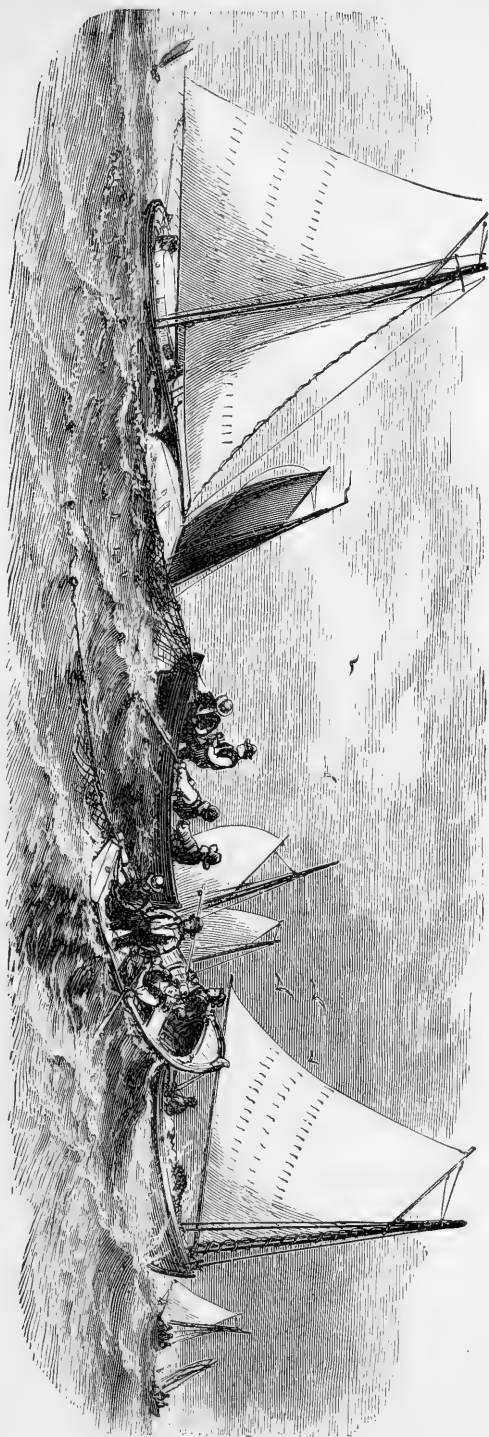


Fig. 32.

W. P. Woodbury & Co. S.C.

Fig. 33.



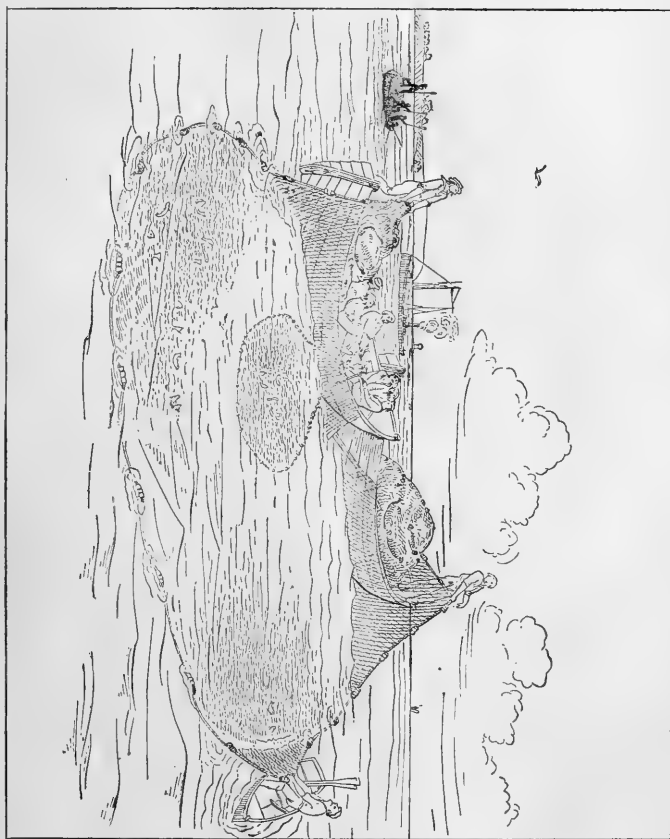


Fig. 34.



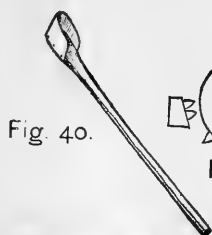


Fig. 40.



Fig 38

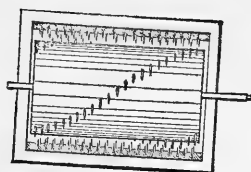


Fig 37



Fig. 36.

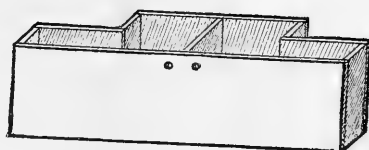


Fig 39.

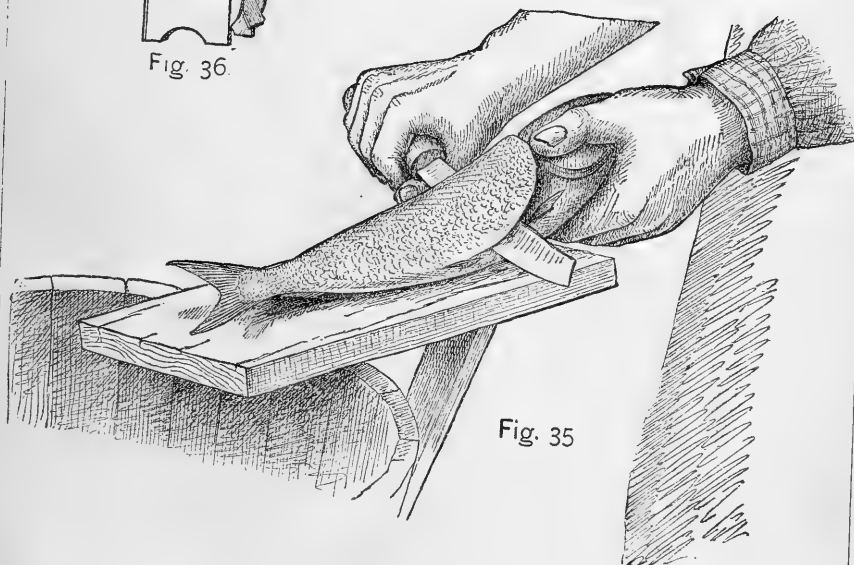


Fig. 35



No 1



No 2



No 3



No 4

Scale of inches.



Fig. 41.



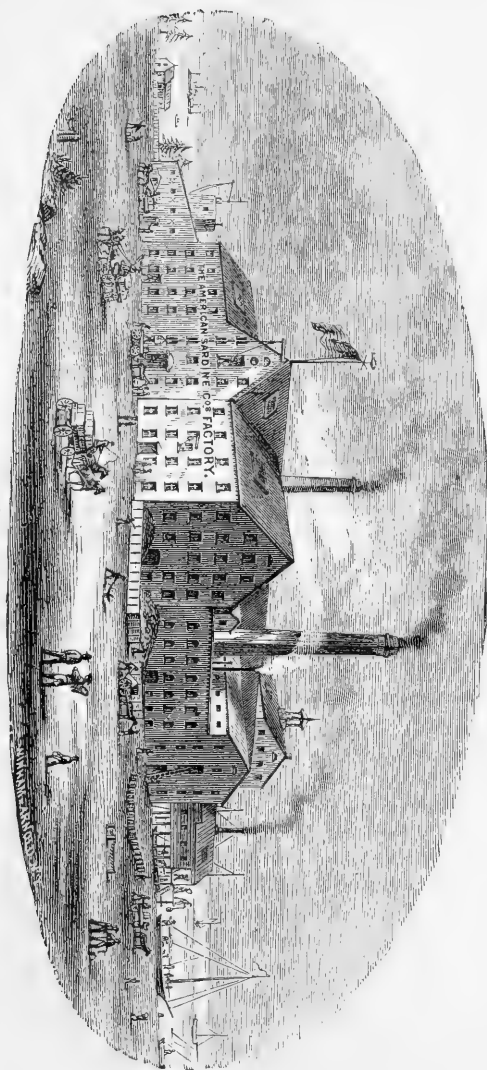


Fig. 42.

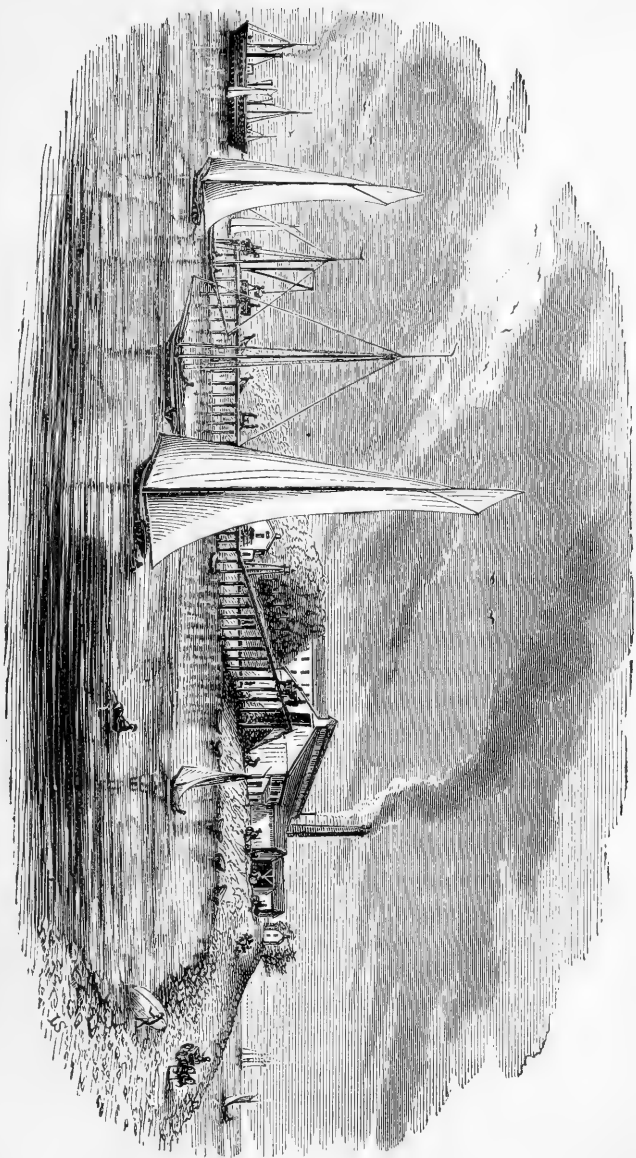


Fig. 43.



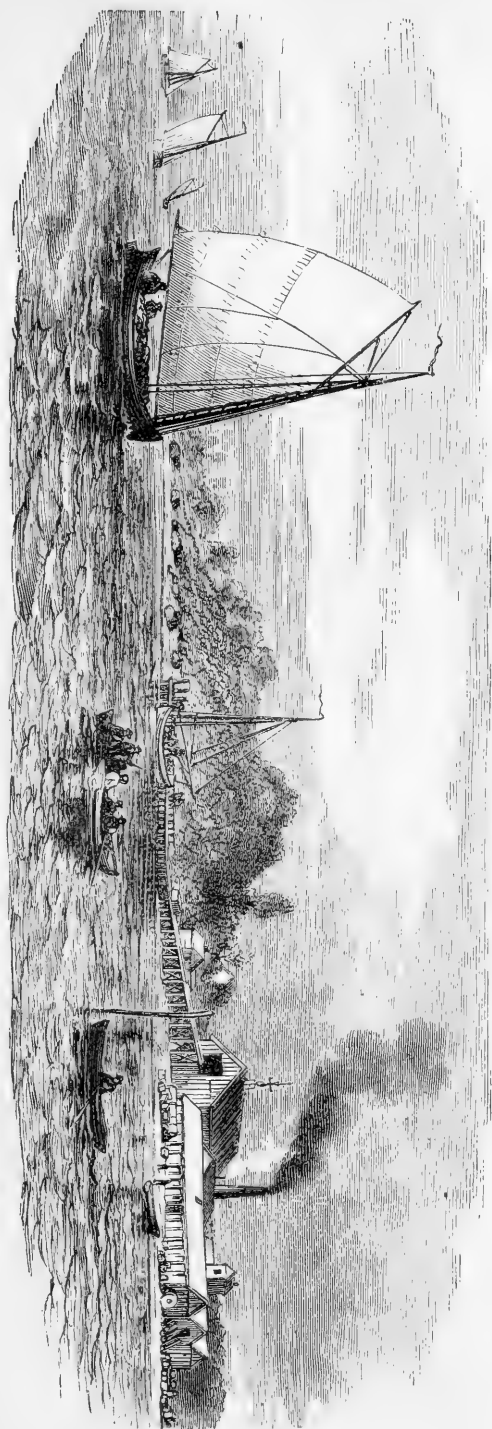


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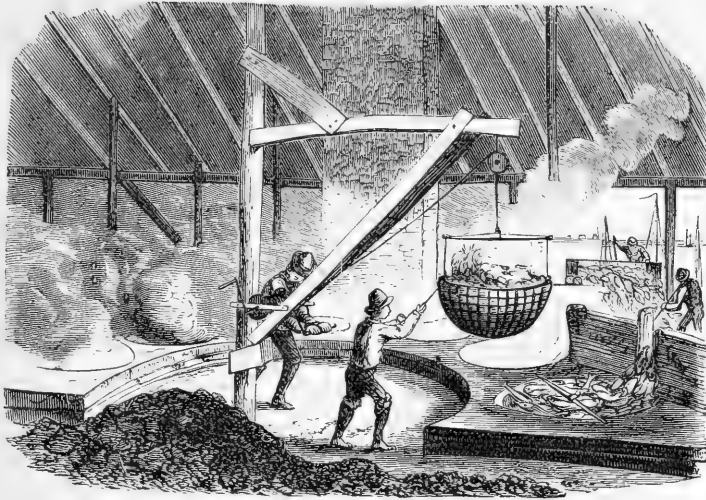


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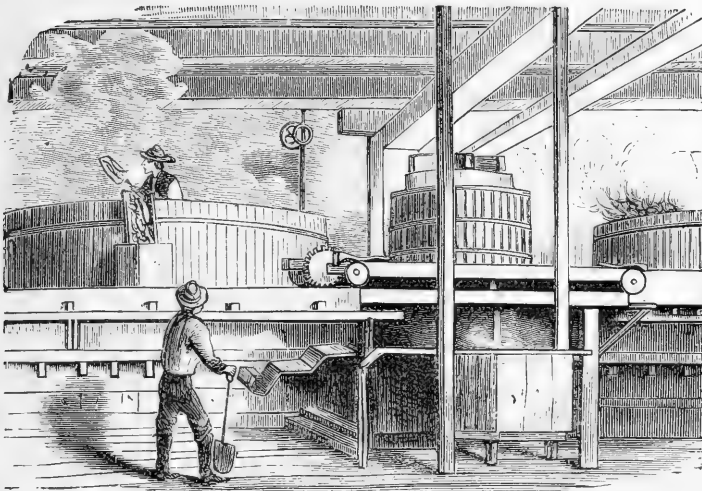


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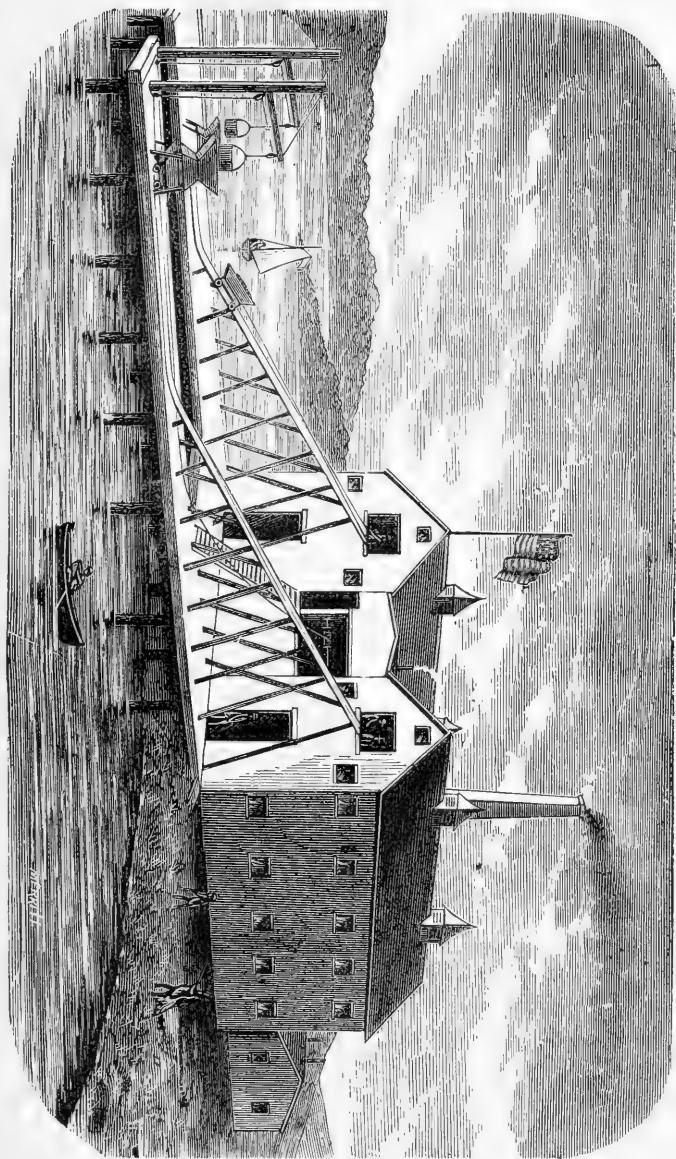


Fig. 47.

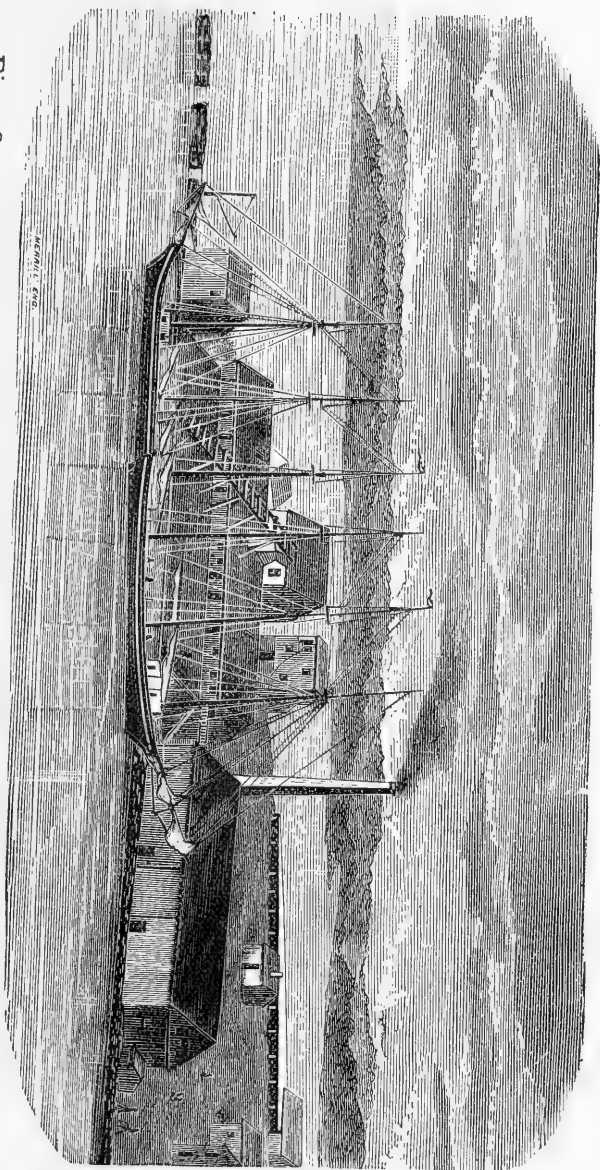


Fig. 48.

J. CHURCH & CO.'S FACTORY, BRISTOL.



CANCELLED.

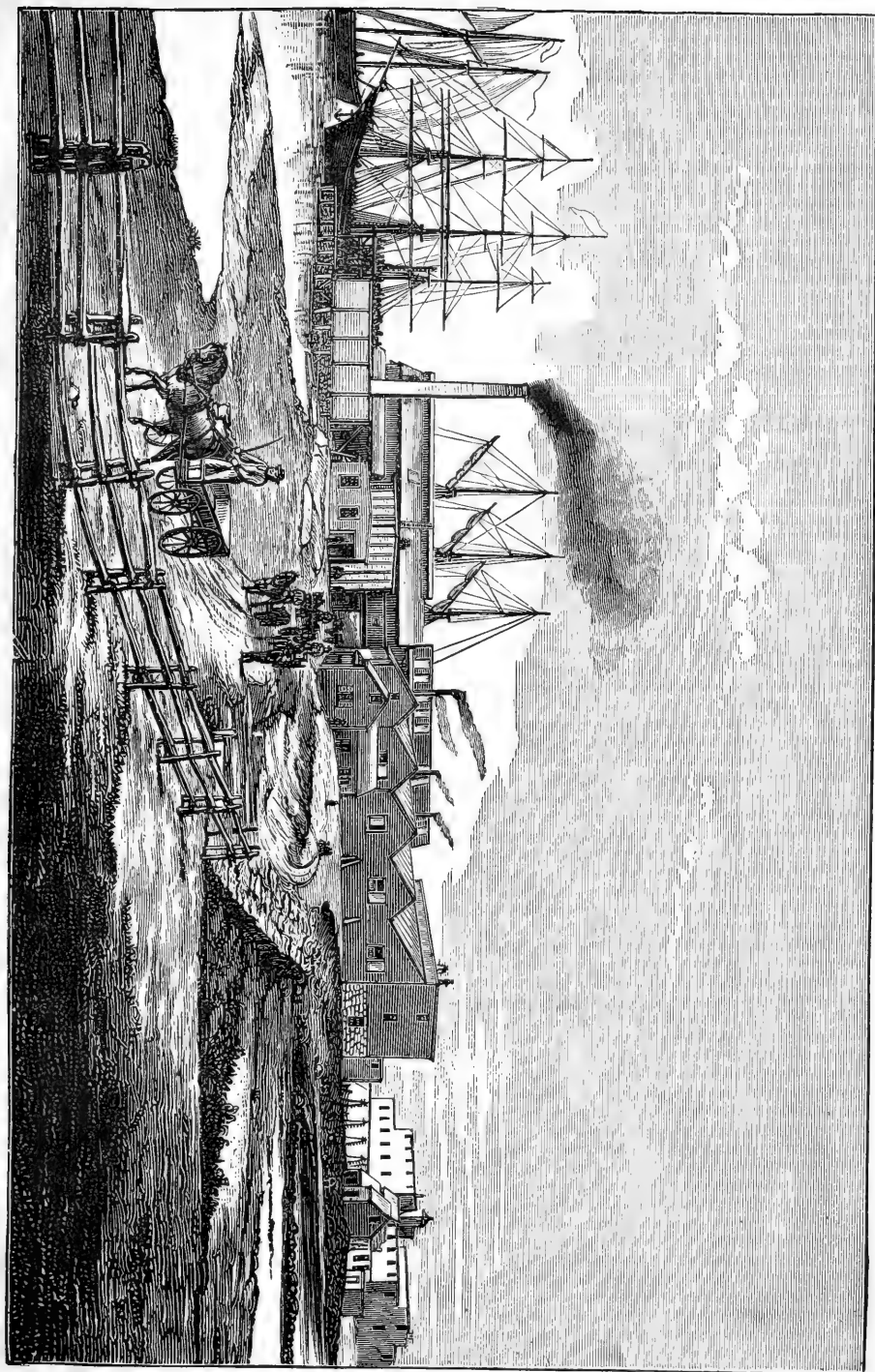
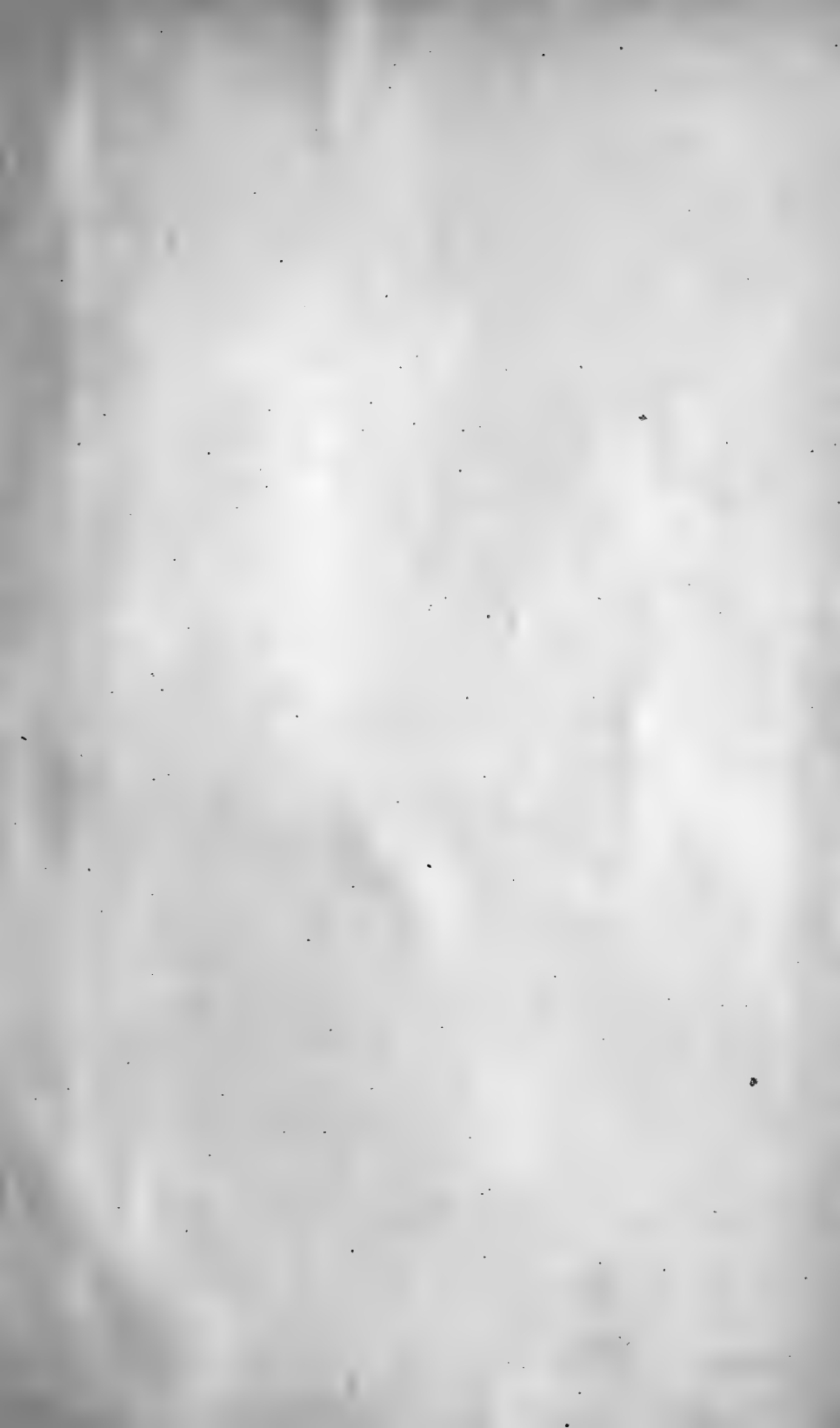


Fig. 50.



22



